Materials in Design Engineering

FORMERLY
MATERIALS
& METHODS

SELECTION & USE OF METALS, NONMETALLICS, FORMS, FINISHES

CUT COSTS, IMPROVE QUALITY: M/DE AWARD WINNERS TELL YOU HOW

page 121

PREVIEW OF DESIGN ENGINEERING SHOW—page 21

AY, 1959

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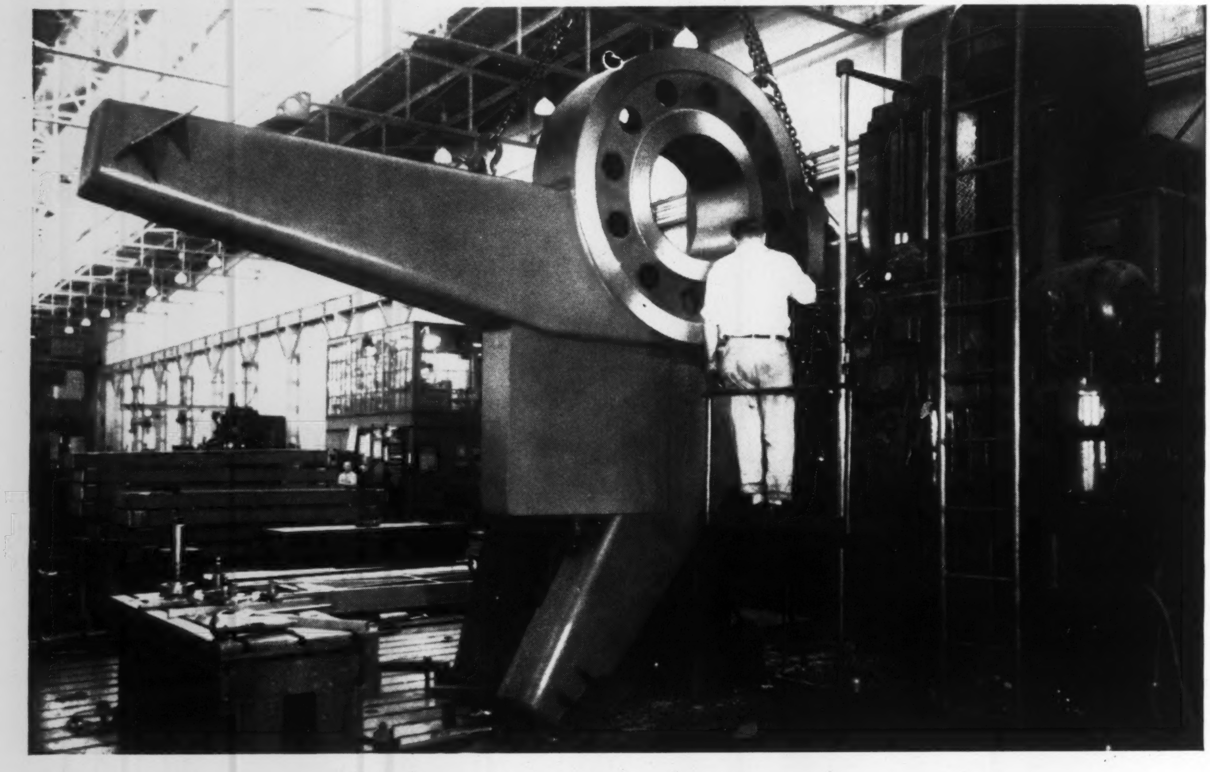
STEEL-WELD FABRICATION . . .



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Materials
in Design Engineering. *formerly Materials & Methods*

Selection & use of metals, nonmetallics, forms, finishes
MAY 1959
VOL. 49, NO. 5

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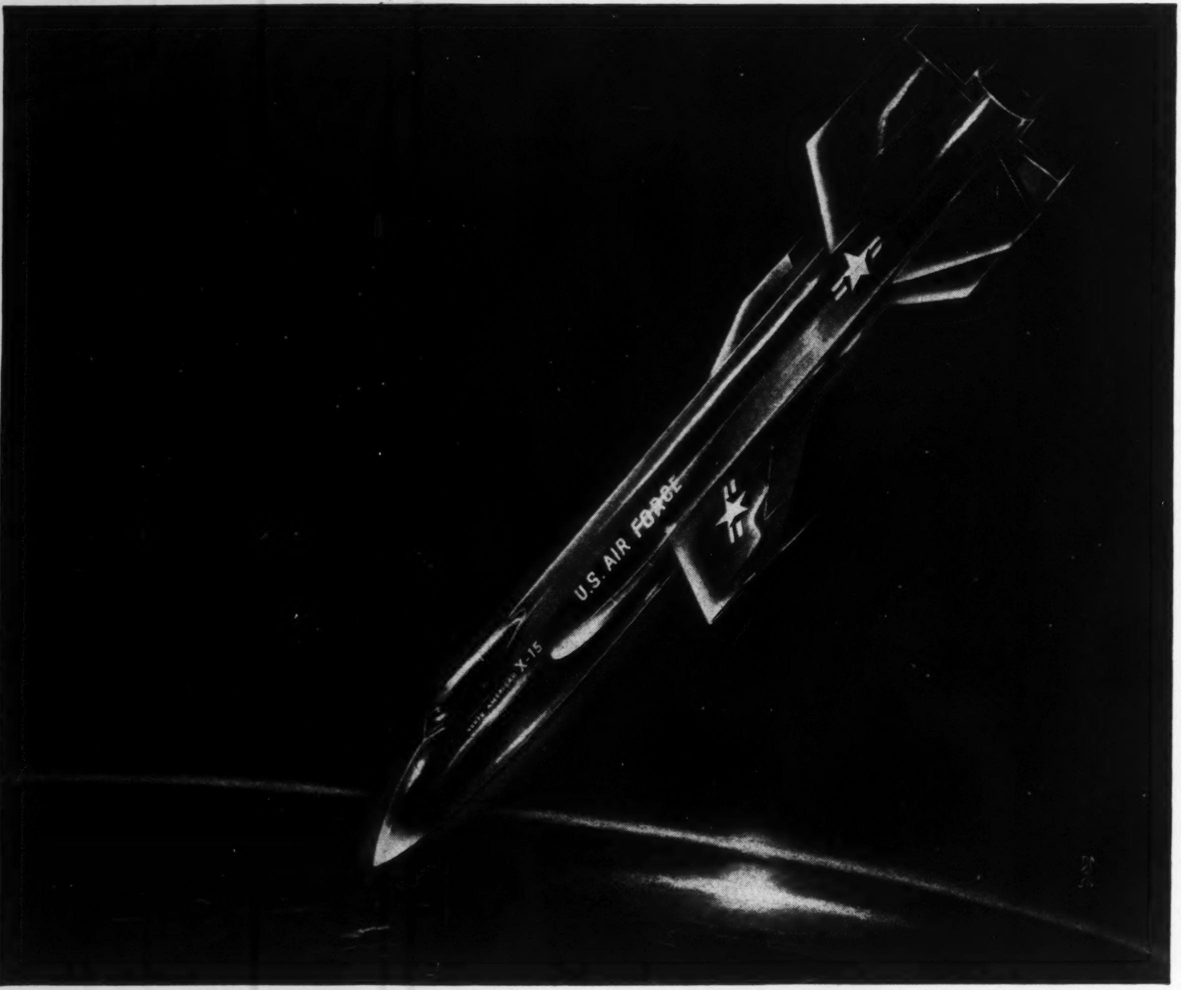
COVER BY HARRY & MARION ZELENKO



Streaking down to earth from space, X-15's skin of Inconel "X" alloy will glow with the dull cherry red of a tossed rivet. X-15, the first manned space-probe ship, is built by North American Aviation, Inc.

How X-15 survives red-hot re-entry

When the first manned space-probe ship, X-15, streaks in from space to re-enter the earth's atmosphere, air friction heats its nose and leading edges to a dull, glowing red in seconds.

Temperatures as high as 1000°F build up. Temperatures that could easily weaken the skin of the X-15. Temperatures that *melt* aluminum. *Deform* carbon steels. *Destroy* most other materials.

How could designers make it possible for X-15 and her pilot to return safely?

The answer was found in the high-temperature properties of Inconel "X"*, an age-hardenable nickel chromium alloy. Inconel "X" alloy offers the high-temperature strength X-15 needs to make its red-hot comeback into earth's atmosphere.

Does this versatile alloy suggest a way you can get some problem facing you off the ground? Inconel "X" alloy provides good spring properties as high as 1000°F. Its relatively low coefficient of expansion makes it useful for parts which must move within tight clearances at high temperatures. And its oxidation and corrosion resistance at high temperatures are outstanding.

If your design problem involves high or low temperatures, corrosion, stress, fatigue . . . or perhaps a combination of these conditions . . . talk it over with us. One of the versatile Inco Nickel Alloys may be able to bring one of your designs back "home" safely and economically. Write for our new booklet, "High Temperatures Spur Use of Nickel-Base Alloys" for "red-hot" information. It's yours for the asking.

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What's new IN MATERIALS

...AT A GLANCE

An aluminum alloy for use at 500 to 600 F has 20,000 psi tensile strength, 15,000 psi yield strength and 25% elongation after aging 100 hr at 600 F. Comparative figures for aluminum alloy 2024-T4, presently used for high temperature applications, are 10,000 psi, 7500 psi, and 65% elongation. The new alloy also has good resistance to stress corrosion cracking at temperatures up to 600 F. (More details next month.)

Source: Aluminum Co. of America, 1501 Alcoa Bldg., Pittsburgh 19.

Silicon carbide-bonded graphite, now available, shows negligible erosion and no evidence of thermal stress failure in highly erosive environments when subjected to extreme thermal shock and temperatures over 4500 F. The new material is composed of graphite particles embedded in a matrix of silicon carbide.

Source: Carborundum Co., Research & Development Div., Niagara Falls, N. Y.

Neodymium metal is now available in commercial quantities. Heretofore, the rare earth metal was available only as an oxide or salt. The metal shows promise as an alloying element for increasing the heat resistance of magnesium. It has a melting point of over 1800 F and a boiling point of over 5400 F.

Source: Research Chemical Co., Div. of Nuclear Corp. of America, 170 W. Providencia St., Burbank, Calif.

A polyvinyl fluoride film for outdoor applications is now available in developmental quantities. The transparent film, introduced last summer (see M/DE, July '58, p 135), is said to have outstanding weather resistance together with excellent chemical resistance and mechanical strength. Samples of unsupported film have not embrittled or discolored after 10 years' exposure in Florida. Introductory price is $5 per lb.

Source: E. I. du Pont de Nemours & Co., Inc., Film Dept., Wilmington 98, Del.

Titanium alloyed with noble metals (palladium, platinum, rhenium, ruthenium, iridium, osmium and rhodium) has good resistance to reducing acids, recent research indicates. Unalloyed titanium dissolves at the rate of more than 1 in. per year in a boiling 5% solution of hydrochloric acid; the addition of palladium to the metal decreases the rate of corrosive attack to less than 0.01 in. per year. Noble metals do not affect titanium's already excellent resistance to oxidizing media. (More details next month.)

Source: Union Carbide Metals Co., Div. of Union Carbide Corp., Niagara Falls, N. Y.

A skived TFE tape requires no adhesives or chemical treatments for bonding to itself or to other materials. The tape, when wrapped on wire and heated to over 620 F, completely bonds to itself and shrink-fits to the wire. It is said to have a ten-

sile strength about 30% higher than that of regular skived TFE tape and a dielectric strength about 25% higher. The developer does not say how the tape is made bondable.
Source: Dixon Corp., Bristol, R. I.

A method for recording the shape and speed of shock waves in metals can be used to study the effects of explosives on military equipment. The method works as follows: 1) an explosion set off at one end of a metal bar sends a shock wave down the bar at tremendous speeds; 2) a strain gage records the shock wave and transmits it in the form of a flash of light to a calibrated oscilloscope screen; and 3) a Polaroid camera then records the flash of light in the form of a line as the light moves across the screen.
Source: U. S. Army Engineer Research & Development Laboratories, Ft. Belvoir, Va.

Large and small fused silica shapes are being turned out by a new fabricating technique, details of which have not been revealed. The low thermal expansion of fused silica (3.1 x 10^{-7} per °F) is said to make the shapes practically immune to thermal shock and thermal stresses usually set up in the firing of ceramic ware. Potential uses: permanent molds, burner rings, ladles and crucibles. (More details next month.)
Source: Glasrock Corp., 1101 Glidden St. NW, Atlanta 2, Ga.

A technique for spot welding molybdenum sheets together has been developed. Ductile welds are obtained by fusing only the metal in the immediate area where the sheets contact each other; thus less than half of the original sheet thickness is affected by the weld. The spot weld is said to contain only a small amount of contamination since welding is done at low temperatures.
Source: T. R. Finn & Co., Inc., Hawthorne, N. J.

A nose cone made with a specially formulated reinforced ceramic (composition of which has not been revealed) has successfully re-entered the atmosphere after a flight at ICBM range and velocity. The developer says the material resists the blast of a 5000 F rocket engine exhaust and is unchanged by heat shock or erosion. Excessive stresses cause the ceramic to deform rather than fracture.
Source: Avco Research & Advanced Development Div., 201 Lowell St., Wilmington, Mass.

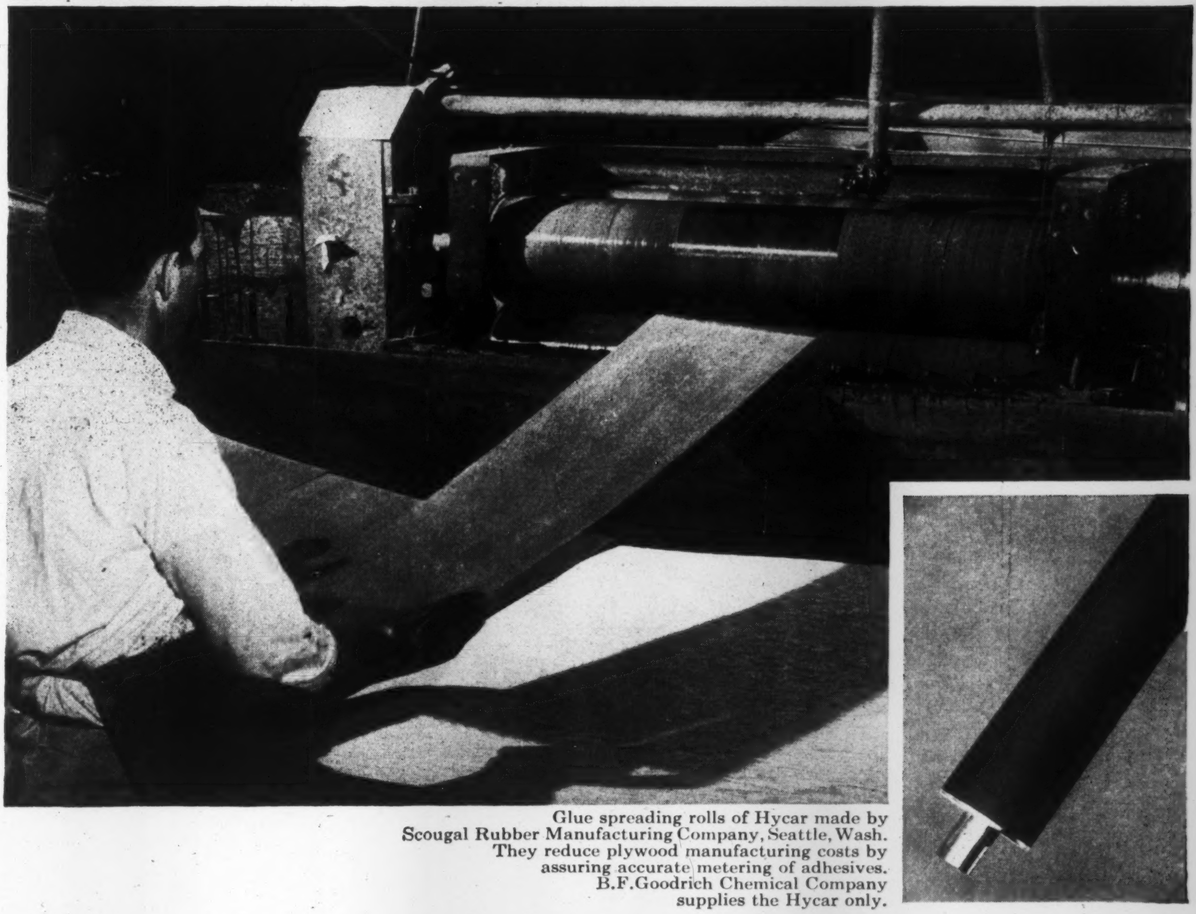
Non-brittle beryllium forgings are made in a few seconds by a new closed-die forging technique in which high purity beryllium powder is pressed under extremely high pressures and forged in a vacuum or protective atmosphere. The forgings are said to have ductility resembling that of strong aluminum alloys, and require a minimum of machining. Previously, beryllium parts were made by machining shapes from rough blocks. (More details next month.)
Source: Wyman-Gordon Co., Worcester, Mass.

A sprayable high density polyethylene coating for application to metals and glass is now available in semi-commercial quantities. The coating, a dispersion of high density polyethylene resin in water or organic solvents, is applied at room temperature and heated to 400 F to fuse the coating to the part. Potential uses: industrial process equipment, appliances, marine equipment, tanks and pipes. (More details in a forthcoming issue.)
Source: Koppers Co., Inc., Plastics Div., Koppers Bldg., Pittsburgh 19.

Turn to page 149 for more "What's New in Materials"

Another new development using

B.F.Goodrich Chemical *raw materials*



Glue spreading rolls of Hycar made by Scougal Rubber Manufacturing Company, Seattle, Wash. They reduce plywood manufacturing costs by assuring accurate metering of adhesives. B.F.Goodrich Chemical Company supplies the Hycar only.

Pleased plywood makers tell...

How spreader rolls of Hycar solve adhesive laminating problems

Until manufacturers of spreader rolls discovered the advantages of Hycar nitrile rubber, spreading adhesives on plywood veneers was quite a problem. The tiny grooves in rolls that are responsible for accurate metering and spreading had to be ground accurately —Hycar lets makers grind to tolerances unusually fine for rubber.

And grooves have to maintain their toughness and posture. Long-wearing Hycar extends life of rolls. Unlike other materials tested, it does not absorb the oils and solvents used in modern glues. Which means the rolls of Hycar can be counted on to meter glue evenly. They are more easily cleaned after use, too.

Regardless of these tough operating conditions, Hycar retains its springy resiliency and vigorous elasticity. It's another example of an improved application made possible through use of Hycar nitrile rubber. You can get more information by writing Dept. CL-2, B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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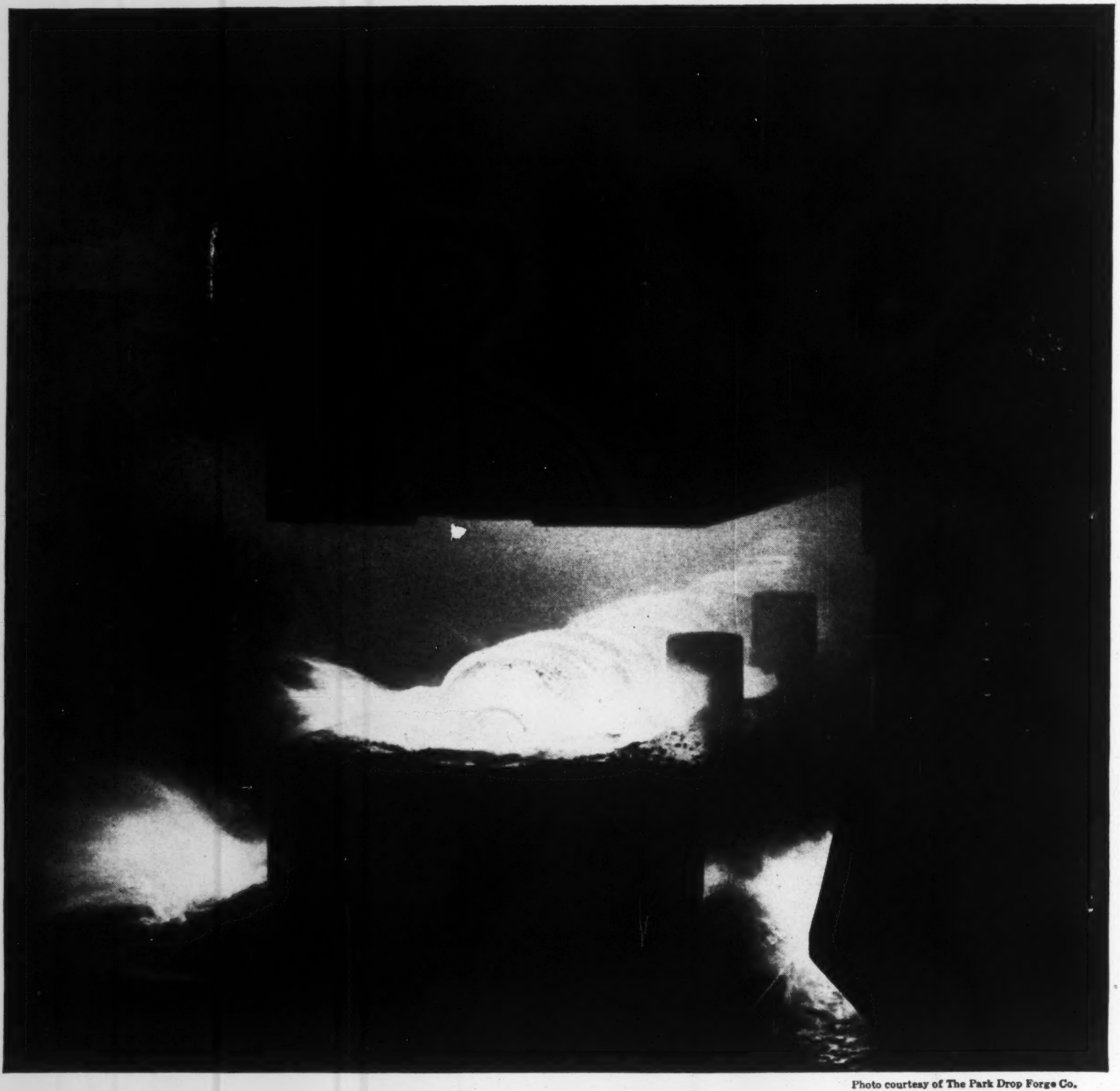

Photo courtesy of The Park Drop Forge Co.

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COPPERWELD STEEL COMPANY

ARISTOLOY STEEL DIVISION • 4021 Mahoning Ave., Warren, Ohio • EXPORT: Copperweld Steel International Co., 225 Broadway, New York 7, N.Y.

For more information, turn to Reader Service card, circle No. 367

MATERIALS AT WORK

...AT A GLANCE

Boat propellers now made of nylon

What are said to be the first large nylon boat propellers to be successfully produced in this country are now in use on a number of ships and fishing craft operating around Greenland and other northern waters. The switch from bronze to extruded nylon 6 has resulted in these advantages: considerably improved resistance to abrasion and cavitation damage, a weight reduction of about 85%, an increase in life of about two to three times, and increased corrosion resistance. Propellers up to 50 in. in dia are planned.

Source: Foster Grant Co., Inc.; propellers extruded by Auburn Plastics, Inc.; used by Columbian Bronze Corp.

First aluminum refrigerator cars

What are said to be the world's first aluminum refrigerator cars are now in service with the Canadian National Railway. The cars were built of aluminum primarily to eliminate expensive repairs and repainting caused by corrosion from the brine solution used in the refrigeration system. In addition, the reduction in weight (over 14,000 lb per car) is expected to reduce operating costs. The cars are constructed of all-welded aluminum floors with curved inside side sill sections, aluminum brine tanks, aluminum meat racks, and composite riveted and welded aluminum underframe.

Source: Aluminium Ltd.

Flexible air duct uses aluminized asbestos

A new type of flexible air duct consisting of aluminized asbestos cloth and steel spirals is reducing costs of low velocity air conditioning systems. The ducts, which are said to be crush and puncture resistant, are composed of two elements: asbestos cloth protected with polyester-reinforced aluminum foil and galvanized steel spirals. Major advantage of the duct is flexibility. It can be installed around structural members and in cramped quarters, thereby often eliminating the necessity of cutting through walls and floors.

Source: U.S. Rubber Co.; duct developed by Wiremold Co.

Carbide dies replace steel and save money

The change from steel to cemented carbide for dies used to draw oil well casings has resulted in a five-to-one cost saving—even though each of the carbide dies costs $1200 more than the previously used steel dies. The cost saving is achieved because a carbide die produces an average of 400,000 ft of 7-in. casing as compared to only 3200 ft for the steel die. In addition, the cemented carbide dies reduce the number of scrapped or rejected tubes, give a better finish and permit faster drawing.

Source: General Electric Co., Metallurgical Products Dept.; dies used by Pittsburgh Steel Co.

Padded fibre containers for delicate parts

Riveted vulcanized fibre containers, padded with about 2 in. of urethane foam, are now being used to transport electronic instruments and other delicate equipment. The re-usable lightweight containers are said to be about one-half the weight of equivalent aluminum containers and meet all specfications set up by the Air Transport Assn. The containers are said to be exceptionally durable, tough and resilient.

(continued on p 9)

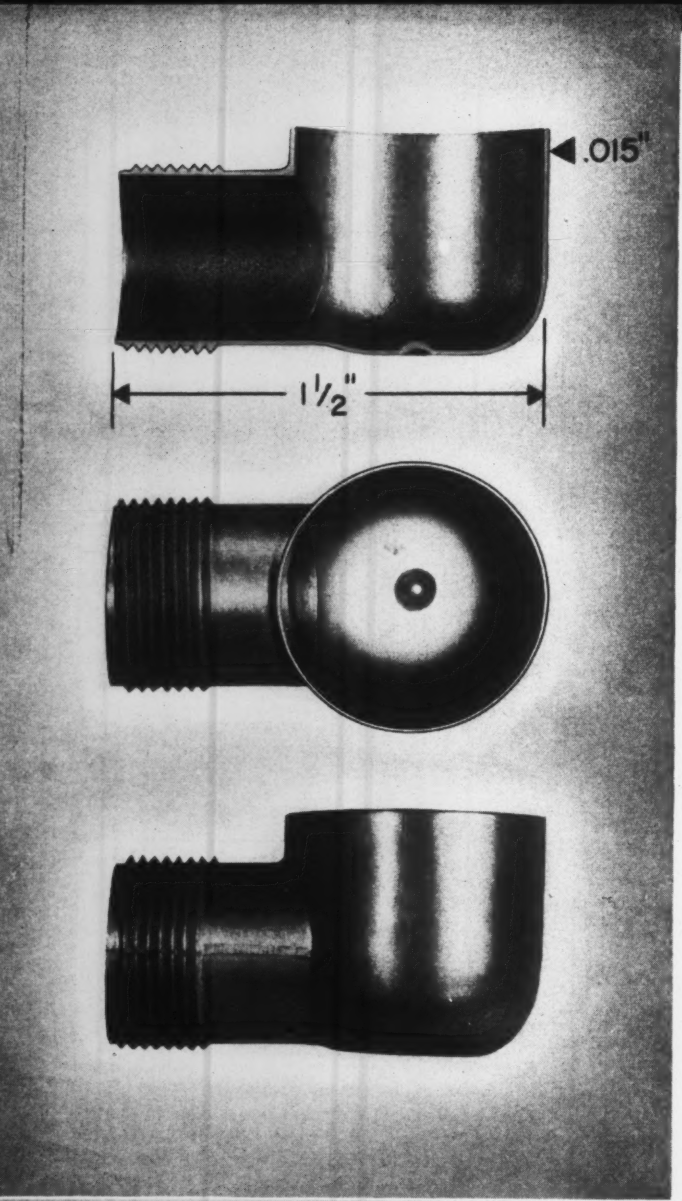
Briefs

Polyethylene-coated milk cartons, which are claimed to be virtually leakproof, are now being used in 25 cities. The containers are extrusion coated inside and out and completely eliminate the previously used wax coating.

Electronic 'brains' may replace human brains if a good skin-grafting technique is ever developed. Latest development is a new method of vacuum depositing complete circuit units which are so small that 10 billion digital computer elements (the number of nerve cells in the brain) could be contained in a unit about the size of a human head.

Self-locking fasteners that turn out to be self-opening are said to be responsible for a major portion of U.S. automobile accidents. In a recent survey, 450 inspectors listed 1262 crashes as being caused directly by faulty fasteners.

IT'S LIGHTER THAN YOU THINK!



AND STRONGER, TOO, WHEN DIE CAST with

ZAMAK

This thin-wall spark plug shield is a zinc die casting with minimum wall thickness of only .015".

Many zinc die castings are as thin as stampings, yet can be produced in shapes that cannot be duplicated as one-piece stampings.

More and more, engineers are learning that they can design parts for ZAMAK alloy die casting that will compete with either steel stampings or castings of the lightweight metals—and at lower cost.

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To increase its life, the foam padding (which covers all interior surfaces) is covered with a heavy canvas.
Source: Continental-Diamond Fibre Corp.

Smallest investment casting cuts cost 62%

By changing from a carbon steel stamping to a miniature investment cast silicon-manganese tool steel, a cost saving of over 62% was achieved in the production of a perforating component used on a teletype machine. In addition to the cost saving, the new part offers greater abrasion resistance, toughness and closer tolerances. The part, said to be the smallest commercial investment casting, has an overall length of less than 0.200 in. A flag-like portion at the top is only 0.045 in. thick. Tolerances are held to ±0.002 in.
Source: Casting Engineers Inc.

Vinyl-coated house siding is easily cleaned

Vinyl-coated aluminum is now being made into house siding panels which are said to require no maintenance, except for an occasional washdown with a hose. The 10-ft long, 8-in. wide panels, which are available in a variety of colors, link together to form a weather-tight V-groove, thus eliminating exposed nail heads. The panels are extremely durable and are guaranteed against blistering, cracking or crazing for ten years.
Source: B. F. Goodrich Chemical Co.; siding developed by Hastings Aluminum Products, Inc.; coating supplied by Sherwin-Williams Inc.

Bronze plating eliminates corrosion

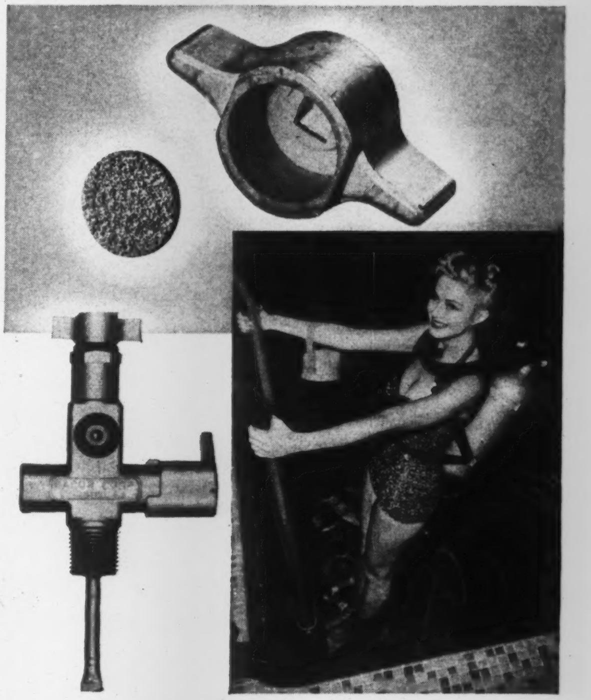
The change from zinc plating to bronze plating has eliminated the dual problem of discoloration and corrosion of lock parts. Previously, the zinc-plated parts tended to discolor the brass and bronze trim used on the locks; corrosion of the zinc was accelerated by galvanic action. Other advantages of the switch: a marked increase in the life of the parts, a reduction in the number of rejects, and elimination of binding on close tolerance parts.
Source: Metal & Thermit Corp.; used by American Hardware Corp.

Silicone finish protects nose cones

The problem of excessive heat build-up during reentry of Redstone missile nose cones has been solved by the use of a special heat resistant silicone-base finish. The finish, which is said to withstand temperatures up to 1000 F, was developed because previously used paints ignited and burnt under simulated re-entry conditions. The finish is also said to be useful for such commercial applications as incinerators, grilles and other products subjected to 500 F.
Source: Midland Industrial Finishes Co.; Redstone missiles manufactured by Chrysler Corp.

(more Materials at Work on next page)

ADVANTAGES SUCH AS THESE
with METAL POWDERS



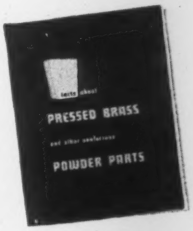
PROVIDE DEPENDABLE
NON-CORROSIVE PARTS FOR THE
DACOR DIVING LUNG

The control knob* for DACOR CORPORATION'S reserve valve was designed for the powder metallurgy process—made in both NICKEL SILVER and BRASS metal powders.

The air filter is also a sintering, in BRASS powder, costing 30% less and providing better filtering action, than the former one made with layers of brass screen cloth.

Only NONFERROUS POWDER METALLURGY can provide these parts at low cost—ready for assembly with a bright, lasting finish without plating.

*by Parker White Metal Company, Erie, Pa.



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will assist you in evaluating this modern production method in terms of your particular needs.

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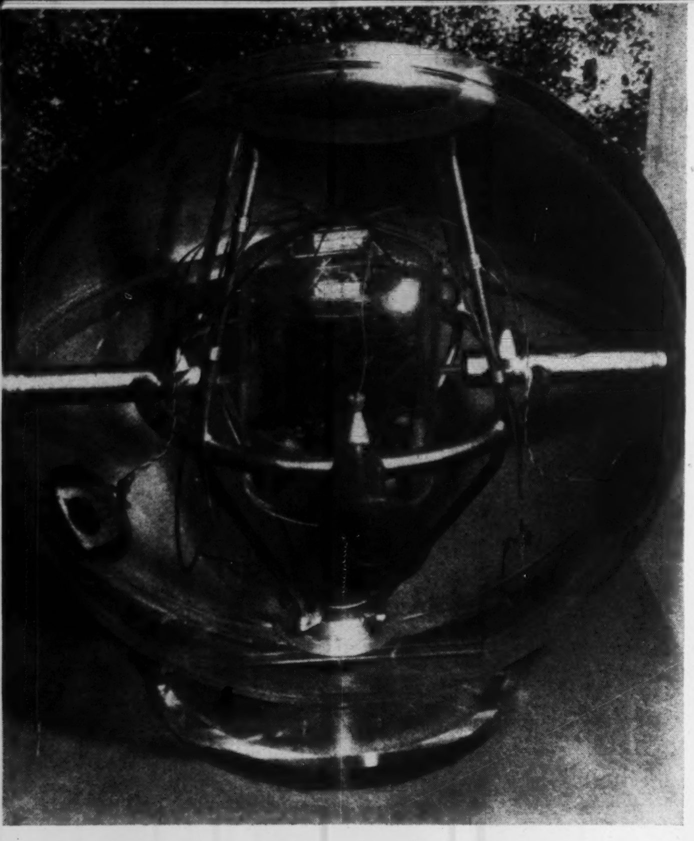
CFE used in rockets and missiles for . . .

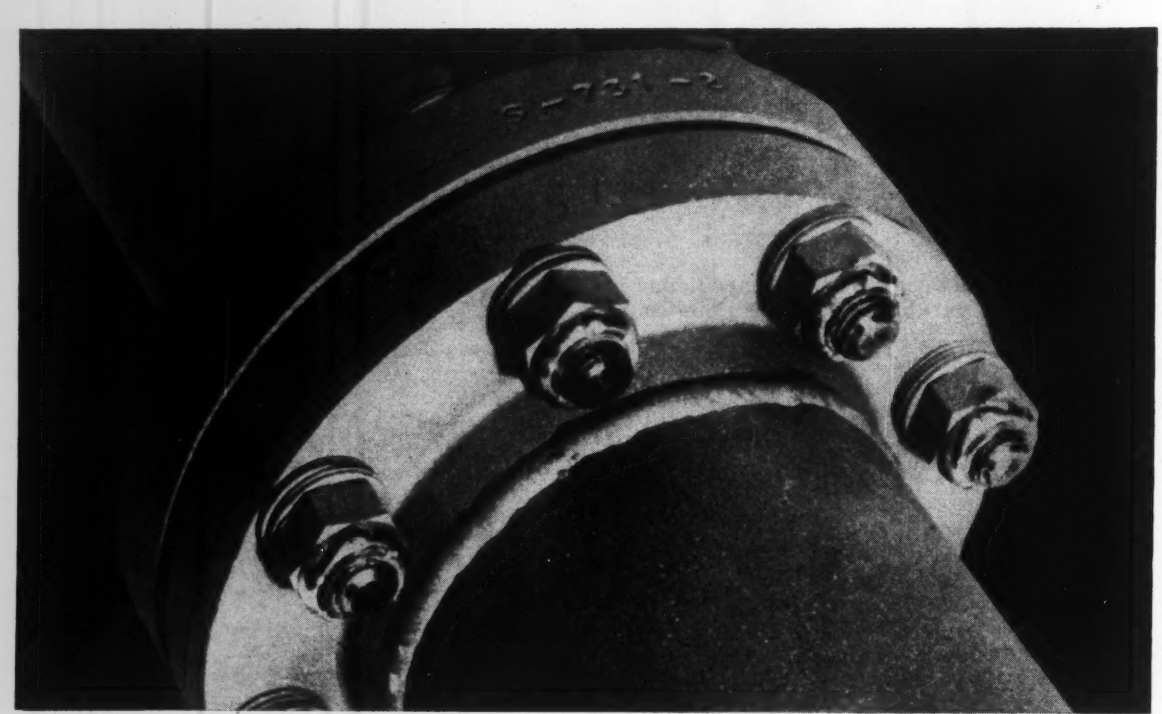
The photos on these two pages show some of the critical uses for CFE fluorocarbon resin (chlorotrifluoroethylene) in the new space technology. All information was supplied by Minnesota Mining & Mfg. Co. For a comprehensive discussion of CFE, see MATERIALS AND METHODS, June '57, p 129.

MATERIALS AT WORK

Edited by Walter Lubars

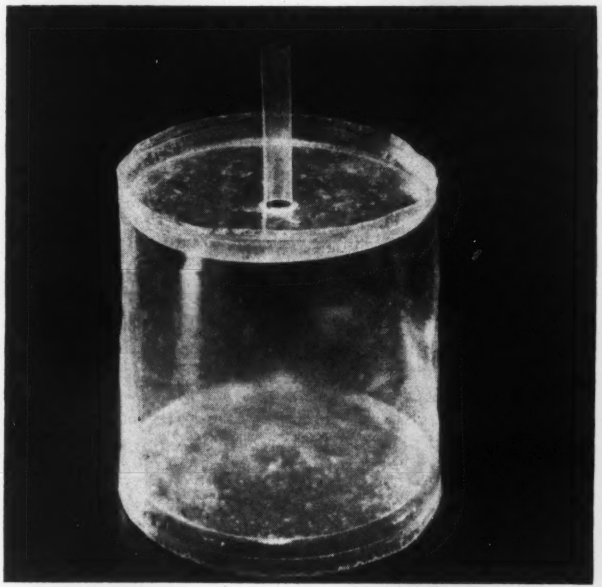


Structural supports because it has good compressive strength, resistance to a wide range of temperatures, and insulating qualities. In the Vanguard satellite shown here, the material acts a thermal barrier between the outer shell and the instrument package.



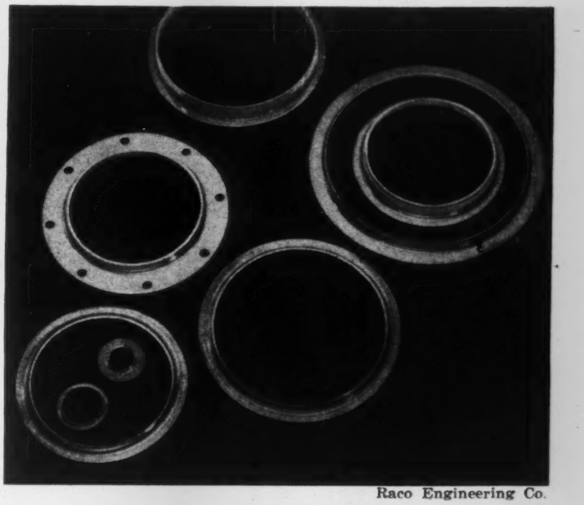
Elastic Stop Nut Corp. of America

Inserts for self-locking nuts because it is resistant to chemicals; will not absorb, swell, shrink or crack; and has excellent impact and compressive strength.



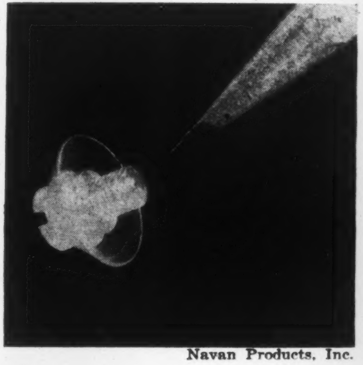
Shamban Engineering Co.

Expellent bladders because it is resistant to chemicals and low temperatures, can be easily injection molded or extruded and can be heat sealed.



Raco Engineering Co.

Lip seals because it is resistant to chemicals and is flexible at very low temperatures. In addition, it can be compression molded, then post formed and machined into the desired shape with tolerance of ± 1.5 mils.

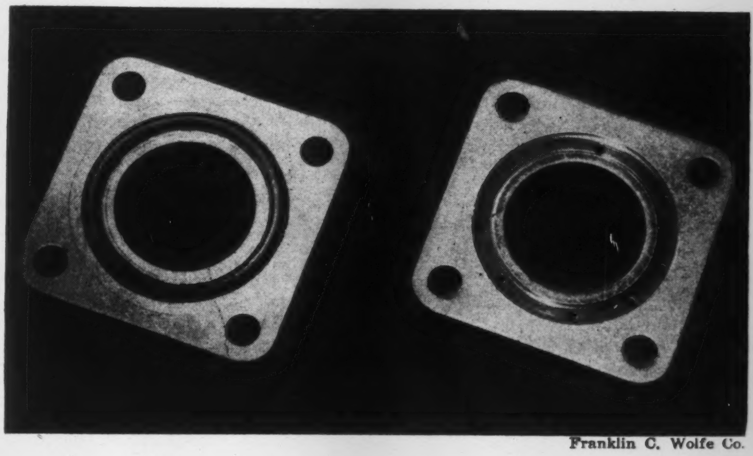


Navan Products, Inc.

Vent seals because it is resistant to moisture and low temperatures, and is easily injection molded.

Coil forms because is has zero moisture absorption, good dielectric strength, excellent dimensional stability and resistance to high temperatures.

American Molded Products Co.

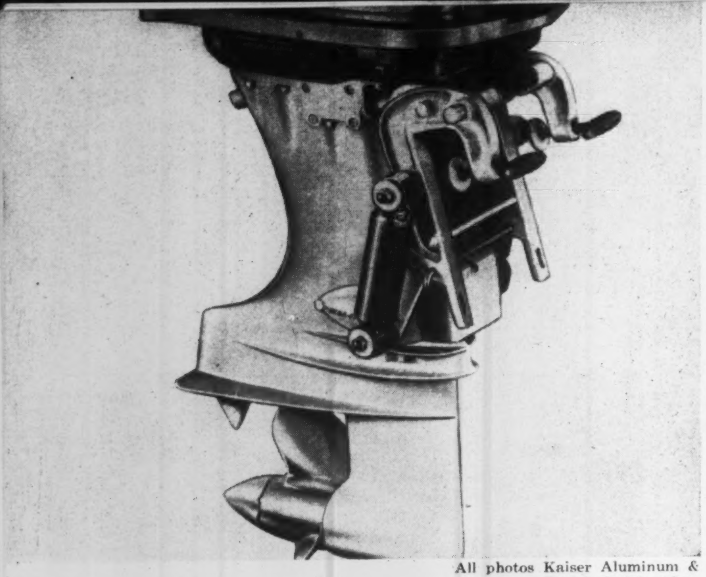


Franklin C. Wolfe Co.

Gaskets because it is the "only applicable elastomer" that will resist nitric acid.

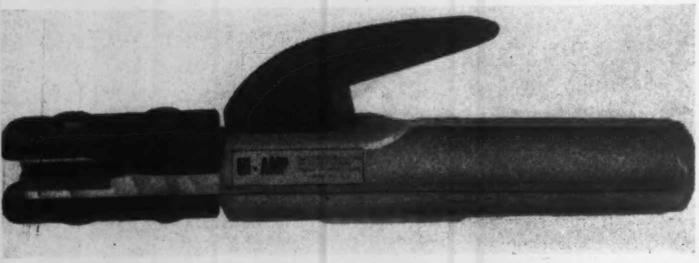
Aluminum forgings gain in commercial products

Aluminum forgings, once used almost exclusively for military applications, are now becoming increasingly popular with engineers and designers of commercial products. The accompanying case histories show why.

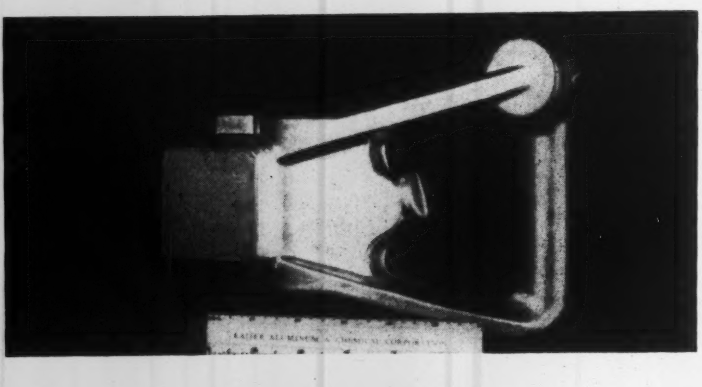


All photos Kaiser Aluminum & Chemical Sales, Inc.

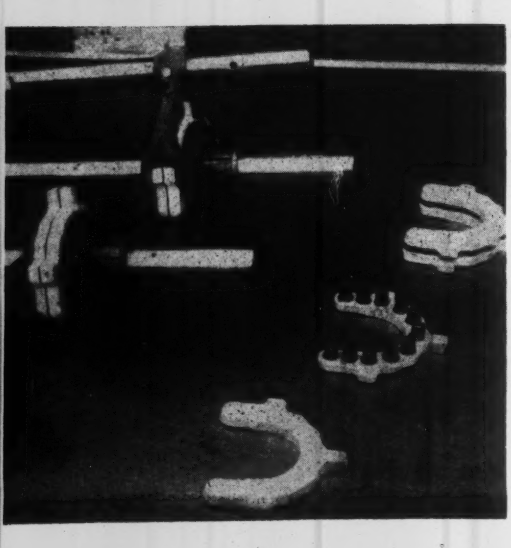
←***Motor clamp brackets*** used to support and clamp outboard motor to transom of boat. *Original material:* aluminum casting; *reason for change:* frequent breakage; *advantages of aluminum forging:* greater strength, lower weight, better finish; *cost:* "a few pennies more per part."



←***Welding electrode holder*** used to clamp and hold electrodes during welding. *Original material:* cast copper; *reason for change:* excessive weight; *advantages of aluminum forgings:* 50% weight reduction, greater strength, good conductivity; *cost:* approximately the same.



←***Tool handle*** for a pneumatic drill used in coal mining. *Original material:* steel casting; *reason for change:* excessive weight, excessive machining; *advantages of aluminum forging:* 60% weight reduction, reduced machining time and cost, ease of finishing; *cost:* "a little more."



←***Clutch pressure plate*** used in heavy earth moving equipment. *Original material:* bronze casting; *reason for change:* insufficient braking qualities, too expensive; *advantages of aluminum forgings:* higher coefficient of friction, improved strength, reduced weight, closer tolerances; *cost:* about 25% less.

MORE MATERIALS AT WORK

Refueling kit gets special pretreatment **217**

Urethane foam fills voids in atomic subs **218**

Welded aluminum boat speeds in rough water **220**

Largest nylon cylinder **222**

90-ton weight saving attributed to T-1 alloy **224**

Largest steel closure formed in one stroke **226**

Corrosion-proof pipe **226**

Reinforced silicone for motor insulation **228**

Vinyl-clad aluminum **230**

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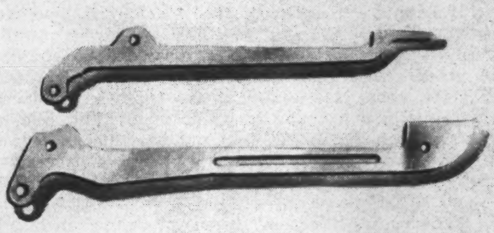
Cold Rolled Spring Steel

HERE'S HOW A "BETTER START" MADE THESE PRODUCTS BETTER:

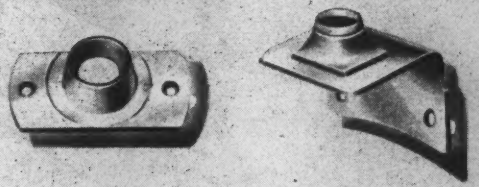
BUSINESS MACHINE PARTS:

- **Eliminated grinding for gauge accuracy**
- **Improved stamping properties**
- **Reduced warpage in heat treatment**
- **Improved forming qualities**



FASTENERS:

- **Improved drawing qualities**
- **Reduced rejects**
- **Lowered production costs**
- **Cut quality control costs**



COLD ROLLED SPRING STEEL MET THESE RIGID SPECIFICATIONS

ANALYSIS: AISI 1055 • **ROCKWELL:** B 85-95
MICROSTRUCTURE: Uniform grain structure and carbide distribution
GAUGE TOLERANCE: ±.0003" including crown
WIDTH TOLERANCE: ±.005"
SIZE: 2" x .0384"
FINISH: No. 2 • **EDGE:** No. 3
COIL SIZES: 200/250 lbs. per in. width

ANALYSIS: AISI 1045 • **ROCKWELL:** B 72 max. Deep drawing qualities
MICROSTRUCTURE: Well rounded and uniformly distributed carbides in a ferrite matrix
GAUGE TOLERANCE: ±.001"
WIDTH TOLERANCE: ±.005"
SIZE: 1½" x .020"
FINISH: No. 2 • **EDGE:** No. 3
COIL SIZES: 200/250 lbs. per in. width

Starting with a better material – quality controlled to *your* exact specifications for the product you make – assures a *better* product – with *important savings* to you.

J&L is your most dependable source for *quality controlled* cold rolled spring steel to standard specifications – or to meet the most exacting demands of your product's custom specifications.

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Letters
to the editor

More on hardness vs brittleness

To the Editor:

A letter in the January issue raised the old question of the hardness-brittleness interrelationship. Questions like this are basic to us in the cold forming business. We try to maintain the workpiece in the plastic state and the tooling in the elastic state, so the boundary between these conditions is very real to us.

I cannot concur with the widespread practice of expressing Young's Modulus in stress units. Actually, it is a measure of the rate of change of stress with respect to strain. The statement that the value is constant means that the relationship between stress and strain is linear. This linearity is lost at the elastic limit and in some materials a new, usually lower, modulus of linear characteristics is achieved. The upper limit of this plastic region is failure of the sample.

The word "hardness" has been defined in many ways. For this discussion, I will assume it to be a function or measure of resistance to plastic deformation. In a bending action a soft (ductile) material will resist bending, according to Young's Modulus, until the maximum fiber stress exceeds the yield. At this point, localized plastic flow takes place and the bar will continue to bend with accommodations to high stress being made by plastic deformation. A hardened bar, when bent, will conform to Young's Modulus with a higher stress level at the maximum fiber stress area than the soft bar, but when it reaches the yield point it cannot relieve stresses by plastic flow, and so fractures. This same difference in ductility explains the ability of the softer materials to distribute stresses by localized deformation, and so to be less "notch sensitive."

If a steel part is improperly tempered, residual internal stresses will lower the strength. This is most likely in parts of higher hardness, and a good deal of experience in "hard equals brittle" is due to such poor tempering. It should be clear, however, that even for well-tempered parts, post-yield brittleness is natural in hard materials, even though pre-yield strength is higher.

GEORGE L. ANDERSEN
Vice President & General Manager
Production Cold Forming, Inc.
Birmingham, Mich.

Communist danger vs cooperation

To the Editor:

I read with interest your editorial note in the January issue titled "International Bright Spot" concerning the International Organization for Standardization (ISO).

The Standards Committee of Saginaw Valley Chapter, American Society of Tool Engineers, re-

How **B&W JOB-MATCHED TUBING** simplifies fabrication of hydraulic cylinders

- ...The complete range of sizes and types of finish plus close tolerances help to simplify fabricating operations.
- ...Quality control from start to finish in the tube making operations helps to speed up fabrication and to make a better product.
- ...Controlled heat treatment provides desired properties for ease of fabrication.

These are just a few of the reasons it pays to specify B&W Job-Matched Mechanical Tubing.

Call the tubing specialist at your local B&W District Sales Office, or write for Bulletin TB-352 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

B&W

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share a mold—
divide the cost
AT ATLANTIC CASTING

Typical Atlantic Production Mold-Half (18" x 12")

PRODUCTION COSTS FOR PRECISION CASTINGS SHOWN ABOVE WERE SHARED BY THE FOLLOWING COMPANIES:

General Electric Company; Intertype Corporation; Westinghouse Electric Corporation; Air Reduction Corporation; United Shoe Machinery Corporation; I.T.E. Circuit Breaker Company; Ordnance Corps. Dept. of Army; Vonnegut Hardware Company.

PRECISION CASTINGS COST LESS AT ATLANTIC because production molds are shared by up to fifteen different customers and fifty castings. Standard production molds are produced and poured on a continuous basis and when an order for a casting is completed, the portion of the mold vacated is immediately utilized for another casting, while production proceeds without interruption.

TOOLING COSTS CUT!
Atlantic mold-sharing requires only one inexpensive, brass pattern, quickly produced and easily altered.

LABOR COSTS CUT!
Pouring as many as fifty castings in a single mold allows substantial reduction in labor costs per casting. This saving is passed on to you.

LEAD TIME CUT!
Continuous mold production with Atlantic's standardized interchangeable tooling allows immediate adjustments in scheduling to conform to your delivery requirements. Deliveries start in as little as two weeks on new orders—one week on reorders.

SEND OR CALL TODAY FOR ATLANTIC'S NEW CASTING CATALOG.

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PRescott 9-2450

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Letters
to the Editor

signed in a group this January when they learned that their standards work might be channeled through the ASTE to the ISO. The Committee members believe that furnishing such technical knowledge to the USSR and its satellites through ISO agents is in violation of their Society's Code of Ethics. This is especially true in the light of the detailed knowledge which the Communist movement has furnished the United States over the last forty-one years, with respect to its intention to destroy our form of government.

The Committee members believe they would be grossly negligent with respect to the preservation of their country and the fulfillment of their Code of Ethics if they were a party to furnishing such technical knowledge directly or indirectly to any representative of the USSR or its satellites.

C. E. BIERWIRTH
Professional Engineer
Buick Motor Div., GMC
Flint, Mich.

Ceramist or ceramicist?

To the Editor:

I would have been more impressed with the authority of your February editorial if you had correctly spelled the word "cer'amist." It is neither "ceramicist" nor "cera'mist."

MARVIN G. BRITTON
Painted Post, N. Y.

Moly Black

To the Editor:

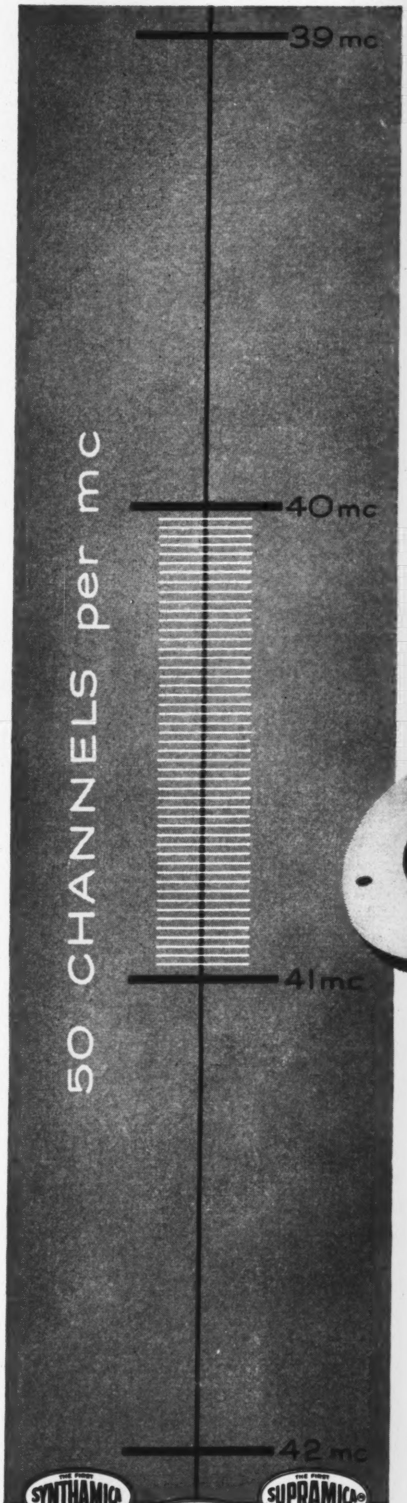
We are seeking information on a coating or finishing process which is applied to brass components of electrical equipment and which is known by the term "Moly Black."

J. F. PRANDONI
Head, Engineering Services Dept.
Office of Naval Research
U.S.N. Underwater Sound Reference Laboratory
Orlando, Fla.

Description of the process, together with names of suppliers of this and similar finishes, has been sent.

Prizes for Your Letters

Each month $10 will be paid for the best letter written to an author, an editor, or addressed to *Letters to the Editor*. We reserve the right to withhold awards.



SUPRAMICA® 555 ceramoplastic

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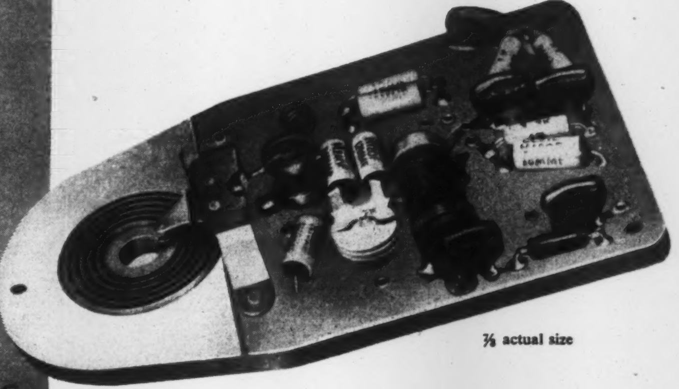

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gives AVCO twice the channel capacity ... in far less space!

This amazingly compact AVCO oscillator circuit, built for a Signal Corps radio receiver . . . 32.5-57.5 mc . . . was made possible by the insulating qualities of its SUPRAMICA ceramoplastic base.

Over a temperature range, in this application, from –67°F to +167°F and, in other uses, at operating temperatures as high as 700°F, SUPRAMICA 555 shows no change, no warpage. It has *complete dimensional stability*. The fragile silver ribbon circuit is molded precisely and permanently in place. Numerous tuning crystals—and their problems—are eliminated. Frequency drift is reduced to an absolute minimum. Channel capacity is doubled.

Other advantages of SUPRAMICA 555: the base can be reproduced *exactly*; electrical loss is negligible; moisture absorption is nil; dielectric strength is high.

Mycalex Corporation of America makes a complete line of precision-moldable and machinable glass-bonded mica and ceramoplastic insulation materials to solve electronic design problems at operating temperatures up to 1550°F. To learn how we can serve you, write *today*.

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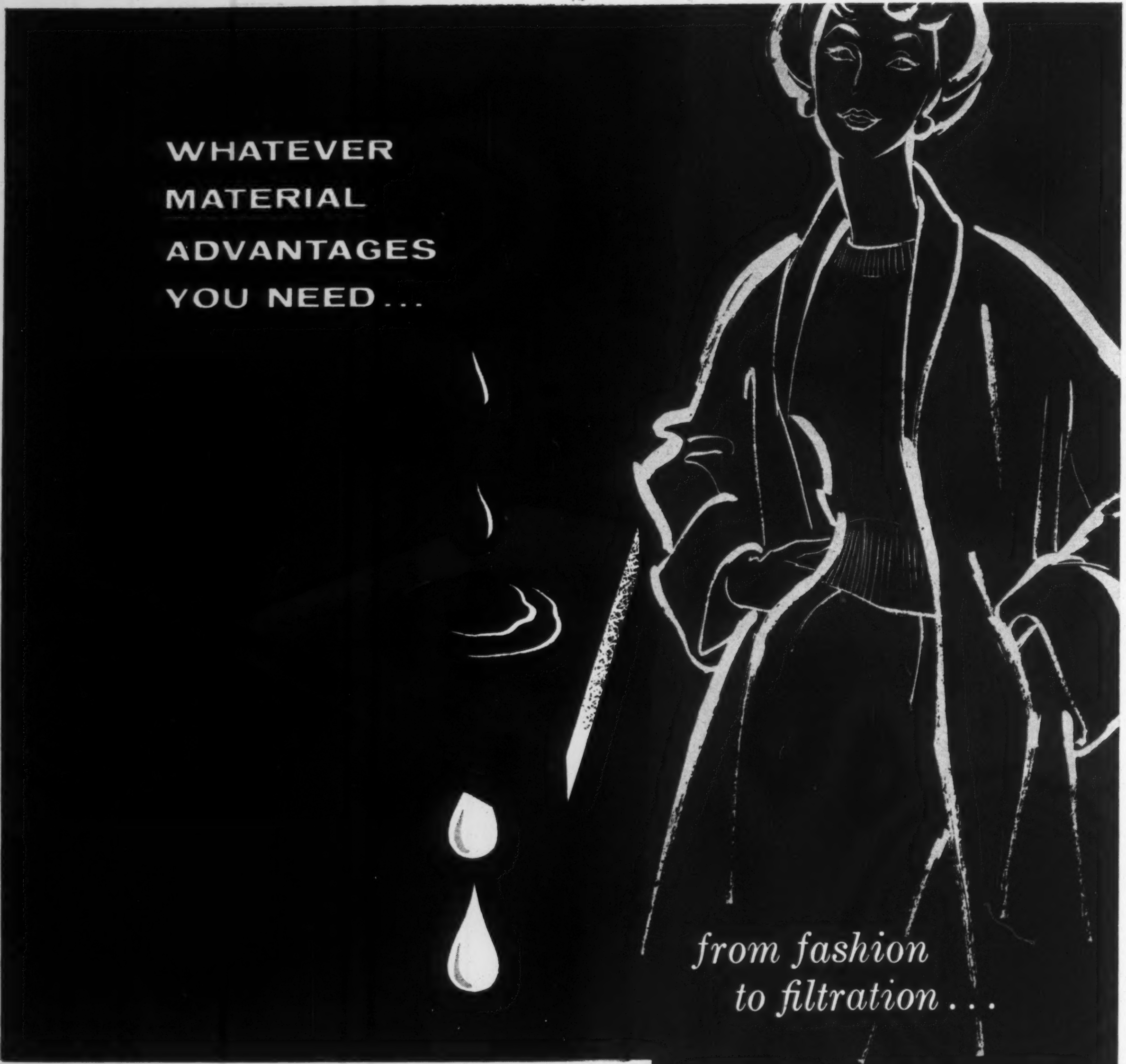
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PRICES AND SUPPLY

...AT A GLANCE

Production of methylstyrene molding compounds has been discontinued by American Cyanamid Co. because it wants to concentrate its efforts in "fields of greater economic promise."

Prices of high temperature steel alloys have been cut by Allegheny Ludlum Steel Corp. The new base prices for forging billets are: Altemp A-286, $1.60 per lb; Discaloy, $1.66 per lb; Altemp 1251, $3.75 per lb; Waspaloy, $6.15 per lb; and M-252, $6.15 per lb. (A new schedule of extra charges for certain size billets was also placed into effect which partially offsets the reductions.) Cuts were also made in the base prices of A-286 plate, sheet and cold rolled strip; new prices are $2.73 per lb for plate and $2.85 per lb for sheet and strip.

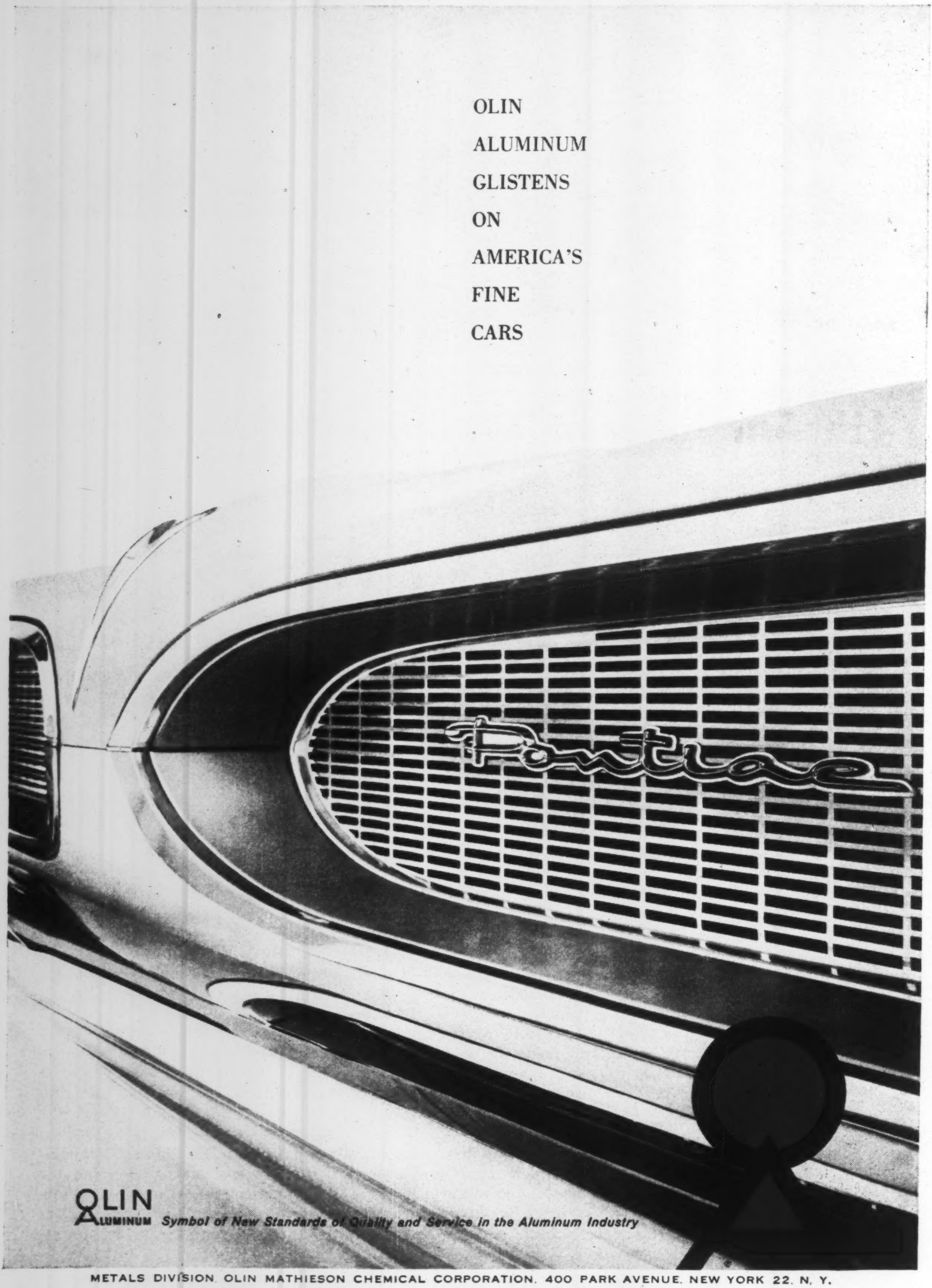
Plastics production reached another all-time high in 1958, according to the Society of the Plastics Industry, Inc.: total production of all plastics amounted to about 4.6 billion pounds, or 5% more than in 1957. Specific figures for some basic plastics are as follows (in millions of pounds): cellulosics 139, down 6% from 1957; phenolics 510, down 5%; polyesters 115, up 20%; polyethylene 920, up 30%; polystyrene 710, up 5%; urea and melamine 332, down 5%; and vinyls 904, up 2%. According to the Society, total plastics production in 1959 should reach 5 billion pounds.

Industrial uses of silver accounted for more than half of the 187.4 million troy oz consumed in this country in 1958. According to American Smelting & Refining Co., the largest and most important industrial users were: 1) photographic field, about 28-32 million troy oz; 2) silver solders for brazing, about 24-27 million troy oz; 3) electrical contacts, about 18-20 million troy oz; 4) batteries, about 1.5 million troy oz; and 5) ceramics, about 1-1.3 million troy oz.

Polyisoprene rubber is now being produced at an annual rate of 15,000-20,000 tons by U. S. Rubber Co. and Shell Chemical Co. The synthetic material is selling for 30¢ per lb, a price roughly equivalent to that of the better grades of natural rubber. The availability of polyisoprene, which is described as the "man-made duplicate of tree-grown rubber," is important because it frees the United States from dependence upon foreign sources in the event of national emergency. B. F. Goodrich Co., Goodyear Tire & Rubber Co. and Firestone Tire & Rubber Co. have pilot plants for polyisoprene production.

More conventional polyethylene is on the way. Latest addition is a new 75-million-pound-per-year plant built by National Distillers Div., U. S. Industrial Chemicals Corp. According to Robert F. Hulse, vice president, the new plant's capacity will be doubled by the end of 1960, bringing the company's total annual production capacity to 250 million pounds. Total U. S. capacity, including expansions now under way, is as follows (in millions of pounds): Union Carbide Corp., 327; National Distillers, 250; Du Pont, 200; Monsanto Chemical Corp., 100; Spencer Chemical Co., 90; Eastman Chemical Products, Inc., 85; Dow Chemical Corp., 50 plus; and Koppers Chemical Co., 25.

Prices of polyvinyl acetate emulsions have been cut 2¢ per lb by both Du Pont and Shawinigan Resins Corp. Du Pont's new prices are 16¢ per lb for homopolymer grades and 18¢ per lb for the copolymer type. According to Du Pont, the reductions make polyvinyl acetate the least expensive of the three most widely used latex resins for water-based paints. (The other two are butadiene-styrene and acrylic.) Within the last 15 years, polyvinyl acetate prices have been reduced by more than one-third.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ALUMINUM
GLISTENS
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OLIN ALUMINUM Symbol of New Standards of Quality and Service in the Aluminum Industry

METALS DIVISION, OLIN MATHIESON CHEMICAL CORPORATION, 400 PARK AVENUE, NEW YORK 22, N. Y.

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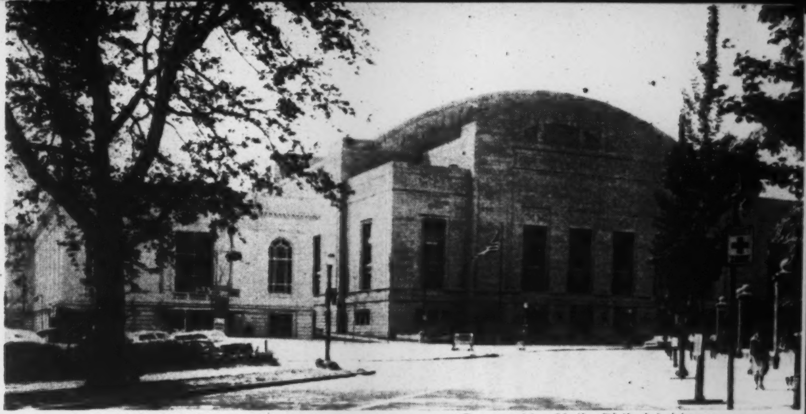


Convention Hall, Philadelphia

PREVIEW

May 25-28, 1959

Design Engineering Conference and

4th Annual Design Engineering Show

The Show

The Design Engineering Show, which has become one of the nation's largest annual industrial expositions, will be even larger and more complete than the extremely successful Show held in Chicago last year. Devoted exclusively to the design engineer's needs, the Show will be composed of exhibits demonstrating the latest developments in engineering materials, services, components and product design.

This year's show, sponsored by Clapp & Poliak, Inc., is devoted to "research and development in industry." Technical experts from more than 400 leading companies will be on hand to give advice, answer questions, demonstrate new materials and processes, distribute technical data, supply samples of new products, and conduct performance tests. The exhibits have been carefully selected and arranged to provide maximum interest and value for those concerned with the selection and use of metallic and nonmetallic materials; finishes and coatings; forms and shapes; fasteners and adhesives; mechanical, electrical, electronic and hydraulic components; and research, testing and other services for product development. (See complete list of exhibitors starting on page 27.)

Visitors will be especially welcome at the MATERIALS IN DESIGN ENGINEERING booth (No. 231).

The Conference

The Design Engineering Conference, which runs concurrently with the Design Show, will cover in detail such subjects as latest developments in plastics, metals and ceramics for high temperature service; materials to resist corrosion; and the mechanical, power and control aspects of design engineering. (See complete program starting on page 23.)

The Conference sessions, sponsored by the Machine Design Div. of the American Society of Mechanical Engineers, have again been planned by the editors of the four leading materials and design publications: *Product Engineering, Machine Design, Electrical Manufacturing* and MATERIALS IN DESIGN ENGINEERING.

In addition to the technical sessions, this year's Conference will again have two general sessions—on the first and last days. The first general session will be devoted to engineering design in Germany and will cover such things as education of German engineers and the relationship of engineering to other phases of industry. The general session on the fourth day will consider general design engineering problems and the effective use of engineers.

In all, 36 speakers drawn from the top level of the nation's design engineers will lead the discussions.

Preview continued on p 23

How to Register—**This year's Show carries a registration fee of $2, which can be paid any time during exhibition hours—from 12 noon to 5:30 p.m., May 25-28 (Monday through Thursday)—at the registration desk in Convention Hall, Philadelphia. Advance rapid registration forms can be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17, N. Y. Registration for the Conference can be accomplished at the ASME desk in the lobby of Convention Hall from 10 a.m. to noon on Monday, May 25, or from 9:30 a.m. to noon, May 26-28; advance registration forms can be obtained from Clapp & Poliak. The Conference fee, $5 for ASME members and $10 for nonmembers, entitles registrants to attend all Conference technical sessions, as well as the Design Engineering Show itself. In addition, each registrant will receive copies of all papers delivered at the Conference.**

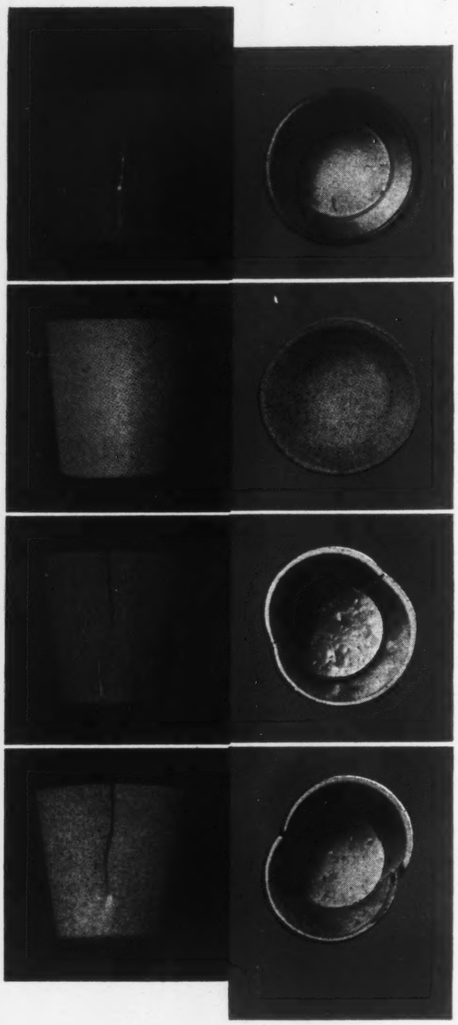
UNRETOUCHED PHOTOS

DRAMATIC PROOF

of **DAPON**® resin's outstanding stability under heat and humidity

As graphically shown here, Dapon Resin does not distort, degrade or discolor under long exposure to high heat and humidity. This outstanding dimensional stability, coupled with Dapon Resin's high electrical properties and chemical stability even under extreme conditions, may provide the answer to your high-temperature high-humidity plastics stability problems.

Dapon Resin is easily compounded with a wide variety of mineral and fibrous fillers and has extremely low molding and post-mold shrinkage. And in addition, Dapon Resin can be molded in a range of solid and pastel colors.



MELAMINE "A"
after 10 days
under test

DAPON
after 90 days
under test

POLYESTER "A"
after 18 days
under test

POLYESTER "B"
after 22 days
under test

TEST DATA: An equal number of test cups were molded under normal conditions from commercial polyester, melamine and DAPON Resin. The cups were half filled with tap water and placed in a laboratory oven at a constant 212°F temperature, the water being replaced daily. The cups were examined at regular intervals and removed from the oven when they had reached the condition shown in the unretouched illustration.

At your request,
we will be glad to send you
complete technical data
on Dapon Resin
so that you can
investigate this unusual plastic
as the answer to
your specific problems.

Properties of DAPON* Resin

Stable, free-flowing white powder • Easy to store, easy to mold, easy to color • Molded products have excellent surface finish • Good physical strength • Low moisture absorption • Chemically resistant • High-temperature and high-humidity resistance • Outstanding dimensional and chemical stability • Fine electrical properties even at high-temperature and high-humidity.

**DAPON Resin is the registered trade name of Food Machinery and Chemical Corporation's brand of diallyl phthalate prepolymer.*

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

FMC Organic Chemicals Division

161 EAST 42nd STREET, NEW YORK 17, N. Y.

For more information, turn to Reader Service card, circle No. 410

← **I. J. Gruntfest**—*Plastics for High Temperature Service.* Thermal conditions encountered in high speed flight, and the four stages a heated material goes through. Materials covered: phenolics, graphite, Teflon, glass-reinforced plastics, and other thermosetting materials.

← **J. J. Harwood**—*Metals and Ceramics for High Temperature Service.* Current approaches to the problem of high temperature service and a comparative evaluation of various materials with respect to their high temperature capabilities, potentialities and limitations. A forecast of future trends is included.

← **S. W. Shepard**—*Materials to Resist Chemical Corrosion.* Latest improvements in the physical and mechanical properties of existing materials; development of new forms of materials; and availability. Materials covered: aluminum alloys, anodized coatings, hardenable stainless steels, ductile iron, fluorocarbons, ceramics and new combination coatings.

← **E. B. Friedl, L. J. Nowacki** and **W. H. Safranek**—*Materials and Coatings to Resist Atmospheric Corrosion.* Protection of steel by organic or metallic coatings. Covered briefly are: recent advances made in combating deterioration by weather; the trend toward solvent-free and water-dispersed coatings; and innovations in electroplating. A comprehensive bibliography is included.

Subjects above will be covered at Materials Sessions.

Program of Technical Sessions

Monday, May 25

10:00 a.m.

General Session: Engineering Design Overseas

Co-Chairmen: DR. JOSEPH W. BARKER, board chairman, Research Corp.; CARL W. BESSERER, assistant program director—Minuteman Project, Space Technology Laboratories, Div. of Ramo-Wooldridge Corp.

Speaker:

"Engineering Design in Germany," HELLMUTH WALTER, director of research, Worthington Corp.

Tuesday, May 26

9:30 a.m.—Three concurrent sessions

Materials Session

Co-Chairmen: JOHN C. REDMOND, manager, new products research, Firth Sterling Inc.; ROBERT N. PETERSON, supervisor, application design group, E. I. du Pont de Nemours & Co., Inc.

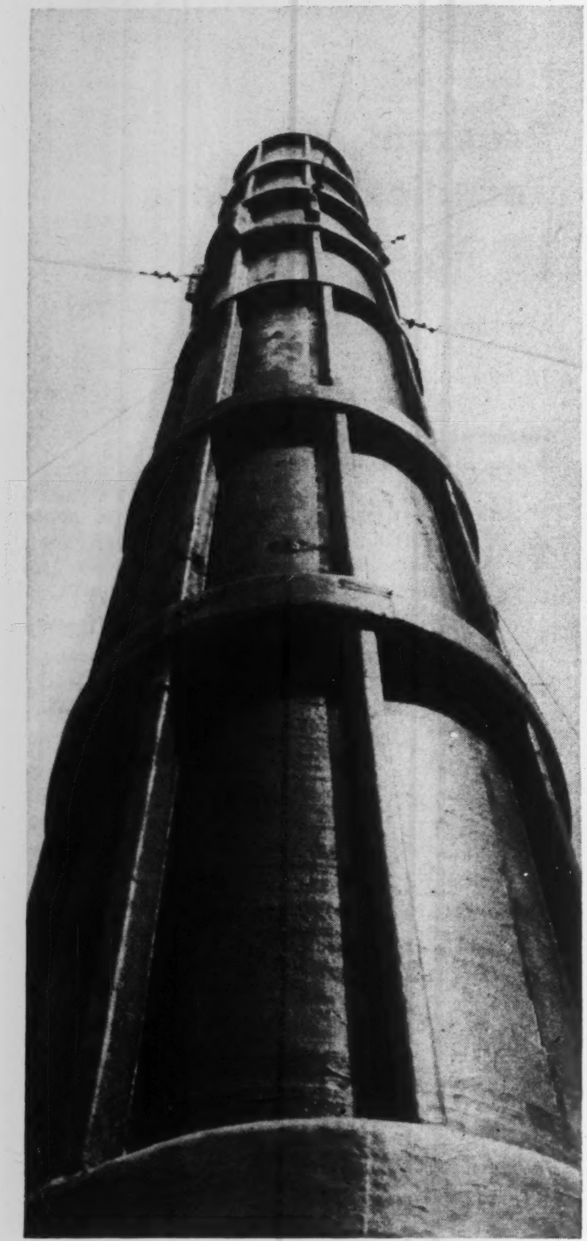
Speakers:

"Latest Developments in Plastics for High Temperature Service," IRVING J. GRUNTFEST, Materials Studies, Aerosciences Laboratory, Missile and Space Vehicle Dept., General Electric Co.

"Latest Developments in Metals and Ceramics for High Temperature Service," JULIUS J. HARWOOD, head, Metallurgy Branch, Office of Naval Research, Dept. of the Navy

CYANAMID

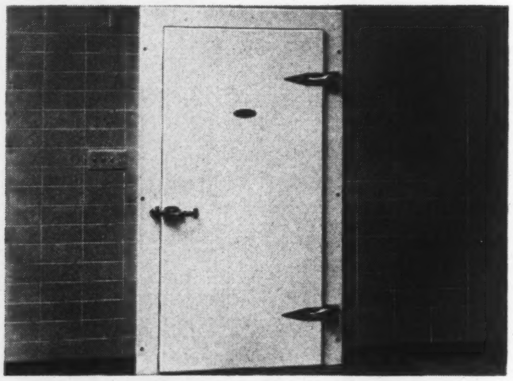
CORROSIONEERING WITH REINFORCED LAMINAC® PLASTIC



Towering Plastic Smoke Stack—To carry off highly corrosive gases such as hydrochloric acid and ammonium chloride fumes, this 84-foot stack was fabricated entirely of glass-reinforced LAMINAC polyester resin. Made by Canbar Industrial Plastics, Waterloo, Ontario, for a Canadian feed and fertilizer plant, the stack is fabricated in three sections. Total weight of the three plastic sections is only 2,055 pounds. Contrary to conventional materials like metal or brick, the prefabricated plastic reinforced stack was erected quickly and requires little maintenance.

BULK MILK
Westfield CO-OP DAIRY
GRADE A MILK

Tank Truck Resists Exposure And Road Hazards—The 800-pound shell used on this dairy truck tank is molded entirely of reinforced LAMINAC polyester resin—including the rear service compartment. The lightweight shell can't rust or rot, and is so strong and impact resistant that when one tank rolled over four times, there was little damage. Lower in cost than steel—and lighter in weight—the reinforced LAMINAC shell increases payload and helps cut license fees. Foamed polyurethane between shell and tank increases insulation efficiency. Little maintenance is required. Made by Walker Stainless Equipment Co., New Lisbon, Wisconsin.



Lightweight Reinforced Plastic Refrigerator Door—It's light weight because it's glass-reinforced LAMINAC polyester resin. Unlike standard steel doors, this revolutionary plastic door is less costly, more impact resistant, *and is permanently corrosion resistant*. Finish and color are molded in—painting or refinishing are unnecessary. The reinforced plastic doesn't absorb moisture, doesn't warp, swell, distort, change shape or rot. And with its polyurethane foam filler, the plastic door gives better insulation than steel with standard cork filler. Ideal for supermarkets and dairies, these refrigerator and freezer doors are shipped prehung and framed. Manufactured by Walker Stainless Equipment Co., New Lisbon.

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Power and Control Session

Co-Chairmen: DONALD G. DUTCHER, chief electrical engineer, Hanson-VanWinkle-Munning Co.; R. W. Barnitz, chief electrical engineer, Jones & Laughlin Steel Corp.

Speakers:

"Variable Speed DC Drive Systems," M. H. SLUIS, electrical engineer, Pratt & Whitney Co., Inc.

"DC Conversion Devices," J. J. RHEINHOLD, vice president, Richardson-Allen Corp.

Mechanical Session

Co-Chairmen: FRANCIS L. JACKSON, technical director, Franklin Institute Laboratories for Research and Development; T. R. RIDEOUT, consulting engineer

Speakers:

"Design and Application of Belts, Chains and Gears," E. S. CHEANEY, W. C. RARIDAN and C. L. PAULLUS, principal engineers, Product Development Div., Battelle Memorial Inst.

"Clutch-Fluid Coupling-Torque Converter, Application Considerations and Performance Comparisons," ROBERT W. BACHMAN, application engineer, Hydraulic Div., Twin Disc Clutch Co.

Wednesday, May 27

9:30 a.m.—Three concurrent sessions

Materials Session

Co-Chairmen: DR. E. H. PHELPS, assistant division chief, Chemical-Metallurgy Div. Applied Research Laboratory, U. S. Steel Corp.; R. V. VANDEN BERG, head, Finishes Section, Process Development Laboratories, Aluminum Co. of America

Speakers:

"Latest Developments in Materials to Resist Chemical Corrosion," S. W. SHEPARD, materials engineer, Chemical Construction Corp.

"Latest Developments in Materials and Coatings to Resist Atmospheric Corrosion," E. BURT FRIEDL, principal chemist, Corrosion Research Div., LOUIS J. NOWACKI, assistant chief, Organic Coatings Research, and WILLIAM H. SAFRANEK, assistant chief, Electrochemical Engineering Div., Battelle Memorial Inst.

Power and Control Session

Co-Chairmen: JAY W. PICKING, manager, Control Div., Reliance Electric and Engineering Co.; A. M. KIMBALL, manager, Digital Control Engineering, Director Systems Dept., Westinghouse Electric Corp.

Speakers:

"Digital Systems for Control Applications," ISAAC L. AUERBACH, president, Auerbach Electronics Corp., Narberth, Pa.

"Logic Circuits for Machine Control," EDGAR V. WEIR, consulting engineer, Magnetics, Inc.

Mechanical Session

Co-Chairmen: DUDLEY FULLER, professor, Mechanical Engineering Dept., Columbia University; STANLEY ABRAMOVITZ, president, Continental Bearing Research Corp.

Speakers:

"Design Curves for Journal Bearings," DONALD F. HAYS, research engineer, Mechanical Development Dept., Research Laboratories, General Motors Corp.

"Which Bearing and Why," ARNOLD O. DEHART, research engineer, Mechanical Development Dept. Research Laboratories, General Motors Corp.

Thursday, May 28

9:30 a.m.

General Engineering Session

Co-Chairmen: THOMAS W. HOPPER, president and director, Day & Zimmermann, Inc.; G. L. BROOMELL, director of engineering, Leeds & Northrup Co.

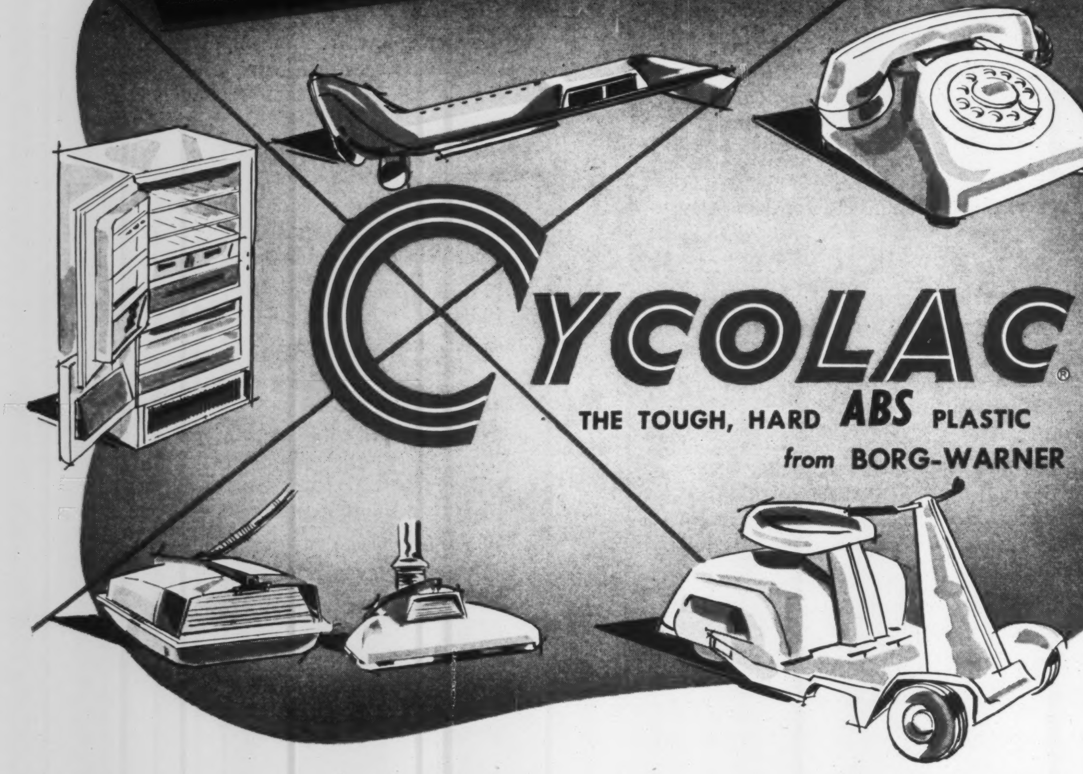
Speakers:

"A Graphic Method for Engineering Organization," E. M. RAMBERG, vice president — engineering, and RANDOLPH P. DOMINIC, assistant to vice president—engineering, Titeflex, Inc.

"The Man and the Organization," DR. MARTIN M. BRUCE, vice president and director, Psychological Services, Clark, Channell, Inc.

Exhibitors on p 27

The NEW dimension in design... The NEW element in production!...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Exhibitors

4th Annual Design Engineering Show

AMP Inc.	515
Acme Steel Co.	807
Acro Div., Robertshaw-Fulton Controls Co.	1030
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Adams & Westlake Co.	1536
Aeroquip Corp.	1132, 1134, 1136
Aircraft and Missiles Manufacturing	1424
Air-Maze Corp.	1624
Air-Shields, Inc.	1648
Alemite Div., Stewart-Warner Corp.	717
Louis Allis Co.	304
Alloy Products Corp.	1459
Aluminum Co. of America	1321
American Laubscher Corp.	1551
American Nickeloid Co.	1603
American Pulley Co.	1646
American Sealants Co.	1653
Amplex Div., Chrysler Corp.	1620
Anchor Plastics Co., Inc.	1049
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Arguto Oilless Bearing Co.	1015
Armco Steel Corp.	1405
Armstrong Cork Co.	117
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Atlas Chain & Mfg. Co.	1402
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Beemer Engineering Co.	1622
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Charles Bond Co.	1210
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W. H. Brady Co.	1038
Bristol Co.	1133
Brook Motor Corp.	1238
Browning Mfg. Co.	911
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Bunting Brass & Bronze Co.	1021
Burling Instrument Co.	1637
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Cherry Electrical Products Corp.	601
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Circle F Mfg. Co.	1009
Clad-Rex Corp.	1455
Cleveland Graphite Bronze Co., Div. of Clevite Corp.	1113
Cleveland Hardfacing, Inc.	1156
Cleveland Vibrator Co.	1636
Cleveland Worm & Gear Co.	513
Coating Products Inc.	1128
Cobehn, Inc.	1619
Colonial Rubber Co.	1342
Columbus Coated Fabrics Corp.	1437
Commercial Filters Corp.	1055
Commercial Shearing and Stamping Co.	1412
Conneaut Rubber & Plastics Co.	1342
Continental-Diamond Fibre Corp.	415
Controlex Corp. of America	1655
Controls Co. of America	1416
Cooper Alloy Corp., Foundry Products Div.	1647
Coors Porcelain Co.	603
Copper & Brass Research Assn.	412
Corbin Cabinet Lock Div., American Hardware Corp.	418
Corning Glass Works	517
Cullman Wheel Co.	313
Cuno Engineering Corp.	1400
Cutler-Hammer, Inc.	1443
Cuyahoga Products Corp.	1349
Dayton Rubber Co.	1512
Delco Products Div., General Motors Corp.	1205
Designers Metal Corp.	1556
Detroit Controls Div., American Radiator & Standard Sanitary Corp.	1511
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Dodge Mfg. Corp.	1105
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A. W. Faber-Castell Pencil Co., Inc.	1011
Fafnir Bearing Co.	1236
Falstrom Co.	1642
Farley & Loetscher Mfg. Co.	1008
Farval Corp.	513
Faultless Caster Corp.	1052
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Fenwal Inc.	1042
Ferguson Machine Corp.	1143
Flexonics Corp.	1155
Flodar Corp.	1249
Foote Bros. Gear and Machine Corp.	319
Formsprag Co.	716
Foundry	333
Franklin Electric Co., Inc.	1121
Fromson Orban Co., Inc.	506
Furnas Electric Co.	1650
Garlock Packing Co.	1413
General Controls Co.	1449
General Electric Co.	215
General Fireproofing Co.	1425
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Glass Tempering Assn.	1048
Globe Co.	1507
B. F. Goodrich Aviation Products Div., B. F. Goodrich Co.	1532
Gordos Corp.	1028
Graham Transmissions Inc.	1154
Gries Reproducer Corp.	1524
Groov-Pin Corp.	312
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Heli-Coil Corp.	324
Heyman Mfg. Co.	1110
Hilliard Corp.	1138
Hitchiner Mfg. Co., Inc.	1520
Hoke Inc.	1125
Hoover Ball and Bearing Co.	704
E. F. Houghton & Co.	607
Huck Mfg. Co.	706
Humphrey Products Div., General Gas Light Co.	1424
Hunter Spring Co.	211
Hydreco Div., New York Air Brake Co.	1053
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Kaiser Aluminum & Chemical Corp.	612

Exhibitors continued on p 29

Handy & Harman EASY-FLO 35 So Effective
Yale & Towne Redesigns 39 Parts for Silver Brazing

See This Being Made at the Design Show

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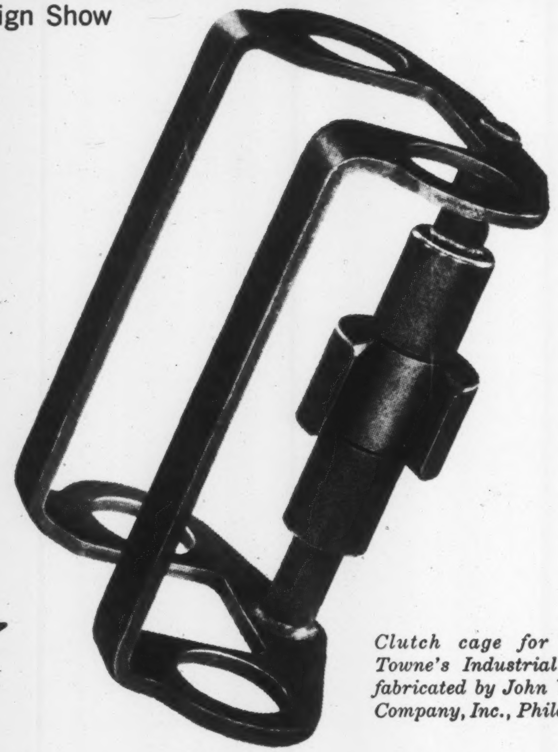
Fork Lift
Clutch Cage
jolt and
accident
proof



Clutch cage for Yale & Towne's Industrial Trucks; fabricated by John V. Potero Company, Inc., Philadelphia.

One of the problems in operating a fast-moving, stop, go and back-up fork lift truck is accidental overtravel of gear-shifting from forward to reverse and vice versa. The result, of course, is a useless unit.

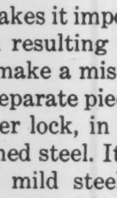
This simple clutch cage makes it impossible to jam a fork lift's gear box with resulting time lost for repair. The operator can't make a mistake.

The frame and shaft, of separate pieces, are made of mild steel. The shift lever lock, in the center of the shaft, is made of hardened steel. It is positioned by two tubular sleeves of mild steel. The entire assembly is hand torch-brazed with EASY-FLO 35 and HANDY FLUX with no loss of hardness.

Welding was considered but rejected because of the necessary follow-up of "spatter" cleaning. With simple silver brazing, flux removal is the only finishing operation required. This, plus the fact that silver brazing is much *easier* (your operator need not be a practiced "torchbearer"), has prompted Yale & Towne to redesign thirty-nine of their parts and components so that they can be brazed.

Come see this part being brazed at the Design Engineering Show in Philadelphia, May 25 through 28; at Handy & Harman's Booth 115. Any questions you may have between now and then about silver alloy brazing and the benefits it imparts to thousands of components, parts and assemblies, may be addressed to Handy & Harman, 82 Fulton Street, New York City 38.

FOR A GOOD START:
BULLETIN 20.
This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.



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Exhibitors *continued*

Kaydon Engineering Corp.	1516
Kennametal Inc.	1325

L. & L. Mfg. Co.	1614
L.O.F. Glass Fibers Co.	512
Laminated Shim Co., Inc.	1022
Lancaster Glass Corp.	500
Landis and Gyr, Inc.	1153
La France Precision Casting Co.	1448
La Salle Steel Co.	332
Lead Industries Assn.	1129
Lebanon Steel Foundry	1411
Lehigh Chemical Co.	1060
G. H. Leland, Inc.	600
Licon Div., Illinois Tool Works	718
Lignum-Vitae Products Corp.	707
Linemaster Switch Corp.	1403
Link Belt Co.	1436, 1438
Lord Mfg. Co.	1552
Lovejoy Flexible Coupling Co.	1504

MM Enclosures, Inc., affiliated with A & P Metal Products Mfg. Corp.	805
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Mac-It Parts Co.	1611
MacLean-Fogg Lock Nut Co.	1043
Mallory-Sharon Metals Corp.	712
Manheim Mfg. & Belting Co.	1158
Marbon Chemical Div., Borg-Warner	1316
Marlin-Rockwell Corp.	1343
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Masland Duraleather Co.	1631
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McCauley Industrial Corp.	1152
McGill Mfg. Co., Inc.	1120
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Meehanite Metal Corp.	218
Messinger Bearings, Inc.	121
Metal Powder Industries Federation	318
Metron Instrument Co.	1031
Miller Electric Co.	1039
Minneapolis-Honeywell Regulator Co.	1051, 1554
Minnesota Mining and Mfg. Co.	1533, 1535
Mobay Chemical Co.	516
Modern Industrial Plastics, Inc.	1544
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Nice Ball Bearing Co.	1108
C. A. Norgren Co.	1239

Ohio Gear Co.	1641
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Ohio Seamless Tube Div., Copperweld Steel Co.	205
Olin Mathieson Chemical Corp., Metals Div.	105
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Panduit Co.	1035
Park Nameplate Co., Inc.	1356
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Pennsylvania Fluorocarbon Co. Inc.	1542
Penton Publishing Co.	333
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Power Transmission Design	406
Precision Metal Molding	406
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Prudential Industries, Inc.	1402

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U. S. Stoneware Co.	1342
U. S. Plywood Corp.	1006
U. S. Rubber Co., Mechanical Goods & Royalite Div.	1228, 1232
U. S. Steel Corp.	1216, 1220, 1224
Universal Castings Corp.	1547
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Valcor Engineering Corp.	1130
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Vlier Engineering Corp.	1044

Wagner Electric Corp.	1142
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Weatherhead Co.	1301
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Weckesser Co.	1633
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Whitney Chain Co.	1509
Edwin L. Wiegand Co.	1200
Winsmith, Inc.	1256
Wittek Mfg. Co.	1500
T. B. Wood's Sons Co.	1117

Zero-Max Co., Sub. of Revco Inc.	700

HERCULES

Plastics Hi-lites

Designers put the heat on thermoplastics

Greater temperature and chemical resistance of newer materials proves a big factor in their growing use

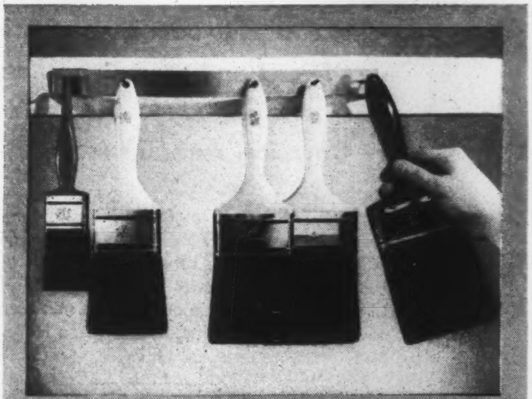
Designers are putting thermoplastics to work today in jobs where no one would have dreamed of using them a few years ago. In many instances, the better resistance to heat and chemicals provided by the newer materials has made it possible to design better looking, more functional products, at lower unit costs. Savings may lie in a number of different directions: cheaper processing, lower material costs, reduced shipping and handling charges, less breakage, or longer shelf life. But above all, it's the styling possibilities of the new plastics that most intrigue the designer, and are stimulating him in the conception of new plastics products, many for markets previously the exclusive domain of other materials. Here are some exciting results of this new trend in design.

STYLISH AND SANITARY . . . A new all-plastic carafe and tumbler set provides a timely answer to the unfavorable publicity about unhygienic bedside hospital water. Manufactured by Zylon Products Company of Pawtucket, R.I., the set consists of a wide-mouth carafe with removable lid, a disposable plastic liner, and a matching tumbler. Carafe, lid, and tumbler are all made with Pro-fax®, Hercules polypropylene, and the plastic's high heat resistance makes it possible to autoclave the entire unit at the termination of a patient's stay. Daily replacement of the low-cost disposable carafe liner insures a clean water supply at all times without daily carafe sanitizing.

BETTER LOOKING AND SAFER, TOO . . . This new Prak-T-Kal vaporizer-humidifier is virtually unbreakable, easy and safe to handle and store. Molded with Pro-fax, the colorful, handsomely styled bowl and lid of this new unit cannot rust, discolor or corrode—advantages provided by this new polypropylene plastic. An automatic shut-off that cuts the current to the heating element before water is completely used, makes it safe to leave this unit unattended even in a child's room. Bowl and lid for the unit are molded by Jamison Plastics, North Bellmore, Long Island, N.Y., and manufactured and distributed by Practical Electric Products Corp., Long Island City, N.Y.

Pro-fax gives wood the brush-off

Pro-fax replaces wood in this new line of TUFLITE paint brush handles, providing a superior product at lower material and production costs.



Pro-fax gives TUFLITE handles in the popular Beavertail style all the merchandising features important in the fast-growing "do-it-yourself" market.

TUFLITE handles are lighter and more durable than wooden models, have a finish that is impervious to solvents, and will not crack, chip, peel, or wear off. Available in a rich array of handsome colors, they are the first plastic brush handles offering colorful styling in a low-cost product.

Not only lower in original cost, TUFLITE handles also cut the cost of brushmaking. Unaffected by humidity changes, they speed handle assembly, eliminating rejects due to shrinkage or swelling.

TUFLITE paint brush handles manufactured by H. V. Hardman Co., Inc., Belleville, New Jersey.

Hi-Fax® serves soap in style

A handsome globe molded with Hi-fax, Hercules high-density polyethylene, makes Bobrick's new line of soap dispensers an attractive asset to any washroom. Much safer, too, since the globe won't crack or shatter if dropped when being refilled. They have a soft lustrous snow-white finish that's easily kept like new by simple damp-cloth cleaning. Bobrick selected Hi-fax after testing other materials for durability and resistance to chemicals. Globes are blow-molded by Olympic Plastics, Inc.

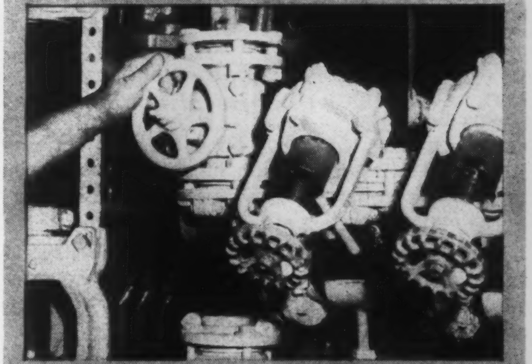
Design Hi-lites

From a designer's standpoint, a new spectacle case molded by Parmalee Plastics for U. S. Safety Supply Company is one of the most exciting uses of Pro-fax seen to date. The cover, hinge, case, and latch are all one piece of Pro-fax molded in a single shot, in a cleverly designed mold. A true plastics paradox, the case and cover depend on the *rigidity* of Pro-fax in achieving a durable, protective package for a delicate product, while at the same time the molded hinge relies on the *flexibility* of Pro-fax in thin-wall sections. If that weren't enough, the resilience of Pro-fax makes possible a strong, snug-fitting latch, which nonetheless releases readily under delicate thumb pressure.

Using the same basic idea, a variety of other such Pro-fax packages suggest themselves for products like cosmetics, tools, toys, or personal goods.

40 months' resistance to corrosive acids

Here's a "proved-in-action" case history of Penton®, Hercules chlorinated polyether—the new thermoplastic polymer with exceptional resistance to corrosion at elevated temperatures. The valve at left in this photograph is a Hills-McCanna diaphragm valve with a cast iron body lined with Penton. It is continuously exposed to carbon tetrachloride, hydrochloric acid, and wet chlorine at temperatures up to 85°C. The valve has operated in this highly corrosive system since September 29, 1955 without a single failure in over forty months. Indicative of the corrosive atmosphere is the use of Haveg, glassed steel, porcelain and Pyrex for other valves and piping in this system. To learn more about Penton in valves, pipe and fittings, pumps and meters, flame-sprayed or whirl-sintered parts, write to Hercules for your copy of "The ABC's of Penton for Corrosion Resistance", and the technical brochure on Penton's properties and uses.



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900 Market Street, Wilmington 99, Delaware

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THREE NEW MATERIALS FOR THE PLASTIC INDUSTRY
HI-FAX® HIGH-DENSITY POLYETHYLENE • PRO-FAX® POLYPROPYLENE • PENTON® CHLORINATED POLYETHER

CP59-6

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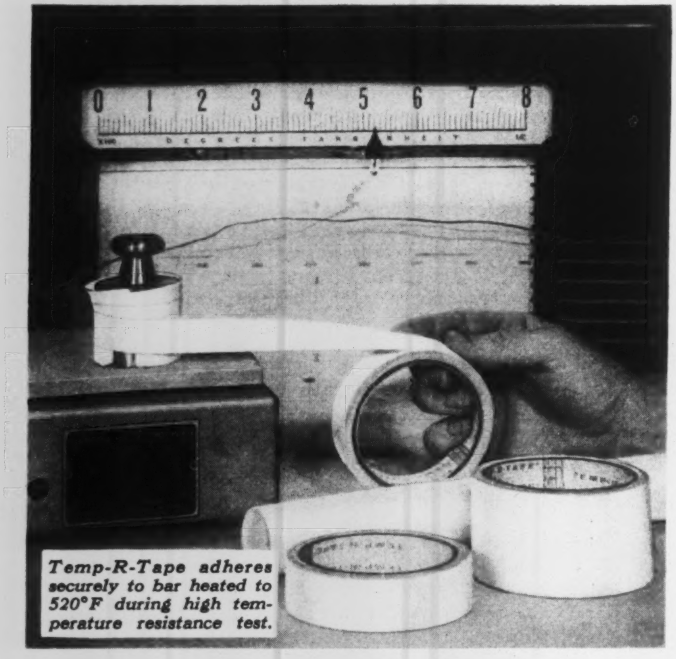
Now 4 CHR High Temperature TEFLON® Tapes



Temp-R-Tape adheres securely to bar heated to 520°F during high temperature resistance test.

Pressure-Sensitive TEFLON Tapes

easy to apply in both electrical and mechanical applications

The electrical uses of Temp-R-Tape include slot lining, interlayer and interphase insulation, harness bundling, wrapping for microwave components, transformer coils, capacitors and high voltage cables, etc.

As a low friction, non-stick facing, Temp-R-Tape applications range from facings for film guides in sensitive electronic instruments to the facing for heat sealing bars, forming dies, chutes, guide rails, etc.

Chemical resistant facing applications include masking tape in high temperature dipping operations.

All four of these pressure-sensitive Teflon tapes are available from stock in rolls and in sheet form. In addition to Teflon tapes, CHR also makes a fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape GV) and silicone rubber coated fiberglass tape with thermal curing, pressure-sensitive silicone adhesive (Temp-R-Tape SGV).

FREE SAMPLES and folder — write, phone or use inquiry service.

— *−100°F to 500°F applications*

— *Class H and Class C insulation*

— *Non-stick and low friction facing*

— *Chemical resistant facing*

TEMP-R-TAPE T is a .006″ pressure-sensitive Teflon tape with −100°F to 400°F (−70°C to 200°C) temperature range. It has high dielectric strength, low power factor, negligible moisture absorption, high elongation, is non-corrosive and non-contaminating. Meets Class H Temperature requirements.

TEMP-R-TAPE TH is a .013″ pressure-sensitive Teflon tape with −100°F to 400°F temperature range. It is similar to Temp-R-Tape T except that it is made of .010″ Teflon film to which .003″ silicone polymer adhesive has been added. Often used where a single, thicker dielectric barrier is desired or where a more rigid, abrasion resistant wrap is required.

TEMP-R-TAPE C is a .002″ pressure-sensitive, thermal curing Teflon tape with −100°F to 500°F temperature range. It is made with a cast Teflon film which provides dielectric strength (2750 v/m) higher than any other type of Teflon film. When cured in place, it will operate at temperatures up to 500°F and will withstand much higher temperatures for short periods. Meets Class H and Class C temperature requirements.

TEMP-R-TAPE TGV is a thermal curing, pressure-sensitive Teflon impregnated fiberglass tape with −100°F to 500°F temperature range. Although it is used extensively for mechanical and electrical applications, its dielectric strength is lower than other Temp-R-Tapes.

CHR products include:

COHRlastic Aircraft Products — *Airframe and engine seals, firewall seals, coated fabrics and ducts*

COHRlastic Silicone Rubber Products — *Silicone rubber moldings and extrusions, silicone rubber sheets, silicone sponge rubber*

Temp-R-Tapes — *Pressure sensitive, thermal curing Teflon and silicone tapes*

Allied Products — *COHRlastic silicone cements and conductive gasketing*

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*is through
the use of
more efficient
materials which
cost less to
machine and
fabricate, yet
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ASARCO

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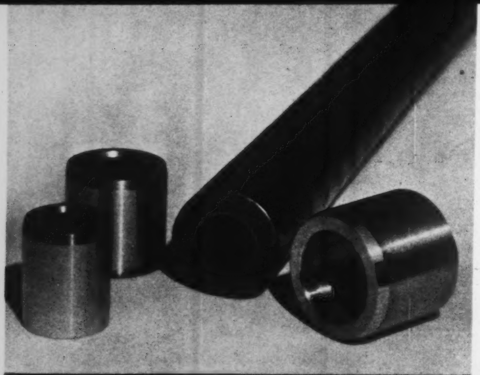
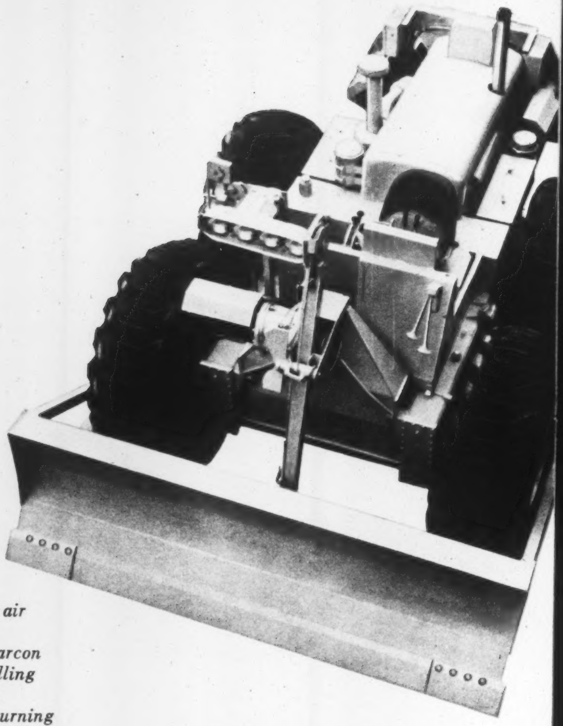




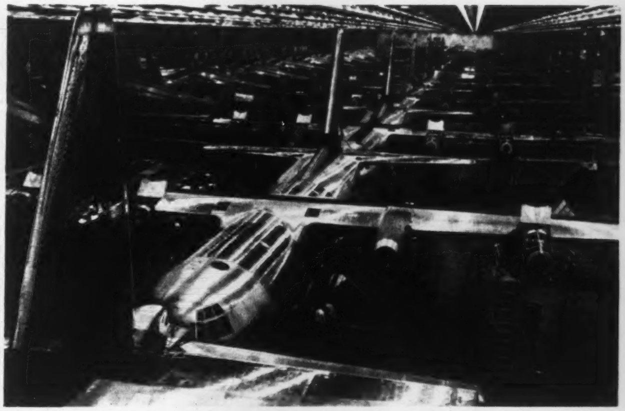
Cushion collars for air cylinders cut from continuous-cast Asarcon tubes eliminate drilling operation, also cut costs of finishing, turning and grinding collars to very close tolerances.

Design for full production efficienc

Motor-drive clutch-ratchet shaft bearings in various Remington Rand calculating machines are continuous-cast from Asarcon 773 Bearing Bronze. These bearings test out 33% higher in impact strength to their sand-cast predecessors!

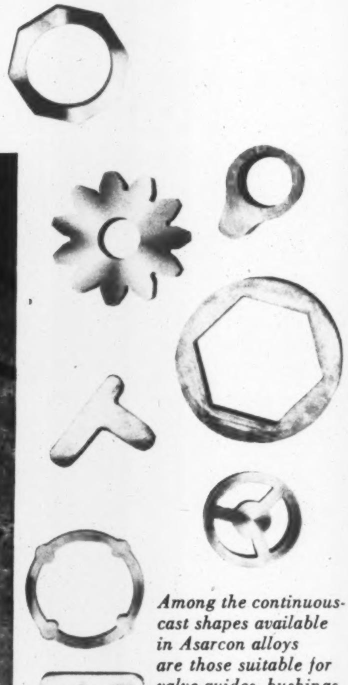
Easy machining and longer wear governed the choice of Asarcon bronze for the worm gears and guide bushings on this power belt sander.

Asarcon bronze, as power transmission bearings in heavy duty equipment, improves performance, extends service life.



Asarcon bronze bearings act as seal against 3000 pounds of oil pressure in control assembly in Lockheed's C-130. These bearings save space, weight. Their great uniformity gives low friction, high load capacity.

CONTINUOUS-CAST BRONZE CASTINGS



Among the continuous-cast shapes available in Asarcon alloys are those suitable for valve guides, bushings, thrust washers, retainers, gears, brake discs, nozzles, seals, sleeves, plugs.

Lower material costs, faster production, better products. Certainly a powerful set of reasons for evaluating Asarco's unique process of casting shapes in continuous lengths. The alloys produced by continuous casting are in accord with SAE, ASTM, and government specifications but their performance is demonstrably superior to similar alloys cast other ways. So superior in hardness, tensile, yield, and impact strength, that you may be able to substitute an Asarcon bronze for a high-cost aluminum—or manganese bronze. You get the shape you need in the exact lengths you need, with minimum clean-up necessary, machinable on high speed machines.

Before you design or produce a copper base part, investigate the economy and efficiency of continuous-casting. From a simple sketch, Asarco can tell you whether or not your part can be economically made from a continuous-cast alloy. Call in your nearby Asarco representative or write to Continuous-Cast Products Department, American Smelting and Refining Company, Barber, N. J. West Coast Distributor: Kingwell Bros., Ltd., 457 Minna St., San Francisco. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

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SMELTING
AND
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Cut your bearing costs 5 ways with

Asarcon 773 (SAE 660) *Continuous-Cast Bearing Bronze*

260 sizes of rods and tubes. Complete range of sizes from 1/2" to 9" diameters. Immediately available from stock in 105" lengths. Special shapes produced to order.

1. No short-end scrap as from ordinary cast bars. Your Asarcon distributor will cut to requirements. You get *exact* lengths you need. Up to 105".

2. Less diameter loss. Asarcon 773, in a complete range of sizes, comes closer to finished dimensions. Only 1/32" to 3/32" to machine off.

3. Less machining. Less stock to remove means less machining time and cost.

4. No loss of machining time, no parts thrown away because of metal defects. Every casting unconditionally guaranteed to be free of blow holes, pits or shrinks. No sand to dull tools. No hard or soft spots.

5. Less down-time. The better, more uniform properties of Asarcon 773 assure longer life of important machine parts and few breakdowns.

Order Asarcon 773 from stock in 260 sizes, solids and tubes, any length up to 105", from a national network of distributors. Write for address of nearest stock point and complete data, to Continuous-Cast Products Department, American Smelting and Refining Company, Barber, N. J. West Coast Distributor: Kingwell Bros., Ltd., 457 Minna St., San Francisco. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

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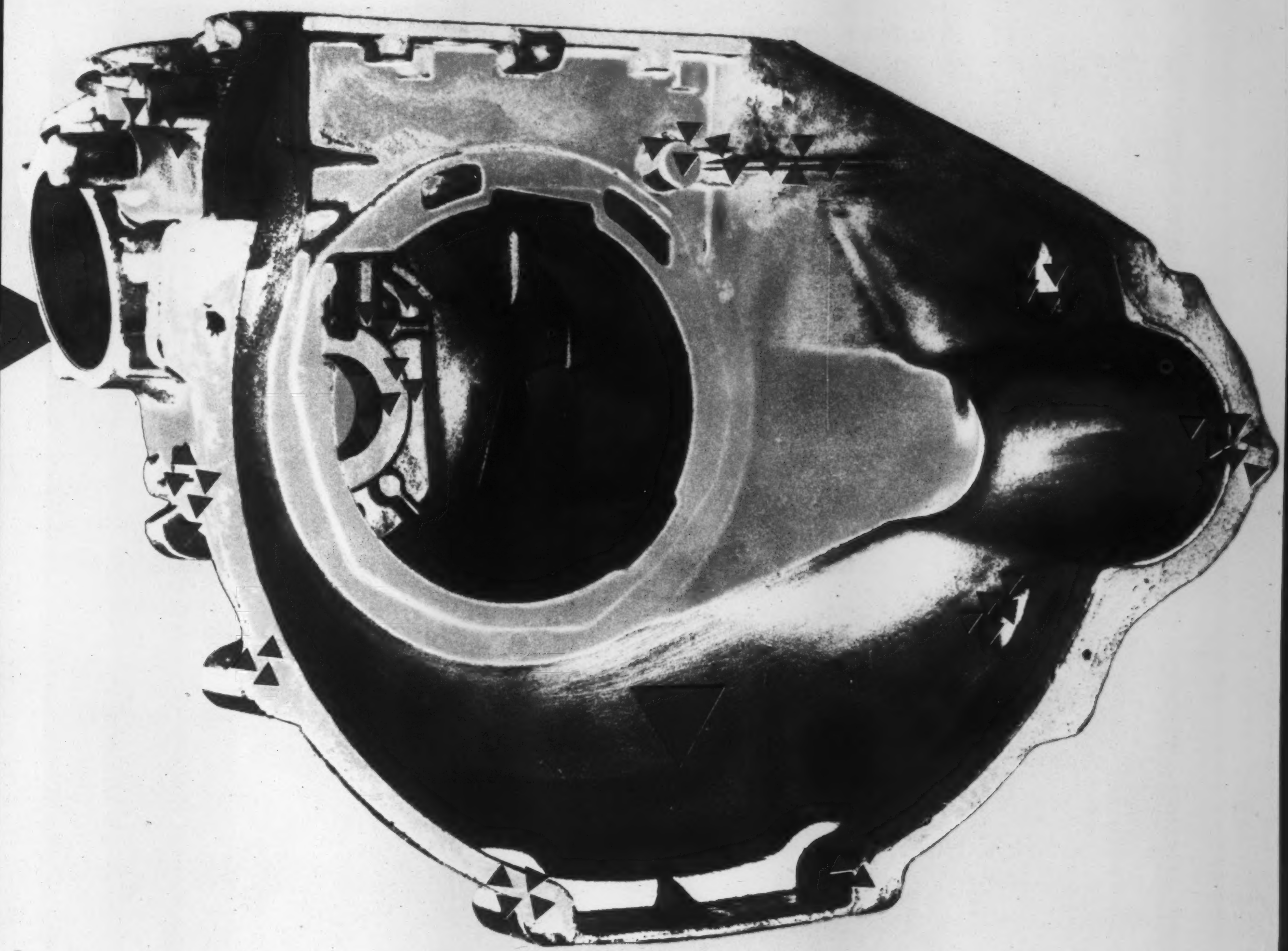

in castings...

Alcoa puts the metal where you want it

The design areas in this permanent-mold casting are pegged in red. The part itself is an automatic transmission housing for the '59 Ford car. It weighs 24 lb, 61 lb less than its cast-iron predecessor. The cyclone forces that whirl through modern automatic transmissions bring stress ranges in some parts of the casting up to 21,000 psi. The problem was to provide adequate strength without unnecessary weight in the casting walls.

Alcoa was not only able to offer a complete test facility, but was able to offer some sound design tips, too. Stresscoat and strain gage tests revealed the areas where special design attention was necessary. We were able to produce the parts to meet the exacting production schedule of the automotive industry.

In castings as well as forgings, screw machine parts, extrusions and impacts, Alcoa puts the metal where you want it. To you, this may mean fewer rejects, or it could provide the key to ingenious solutions for difficult design problems. Start now; write for Alcoa's Up-To-Dater, a starter file of ideas and design tips on Alcoa Engineered Products. Aluminum Company of America, 917 Alcoa Building, Pittsburgh 19, Pennsylvania.

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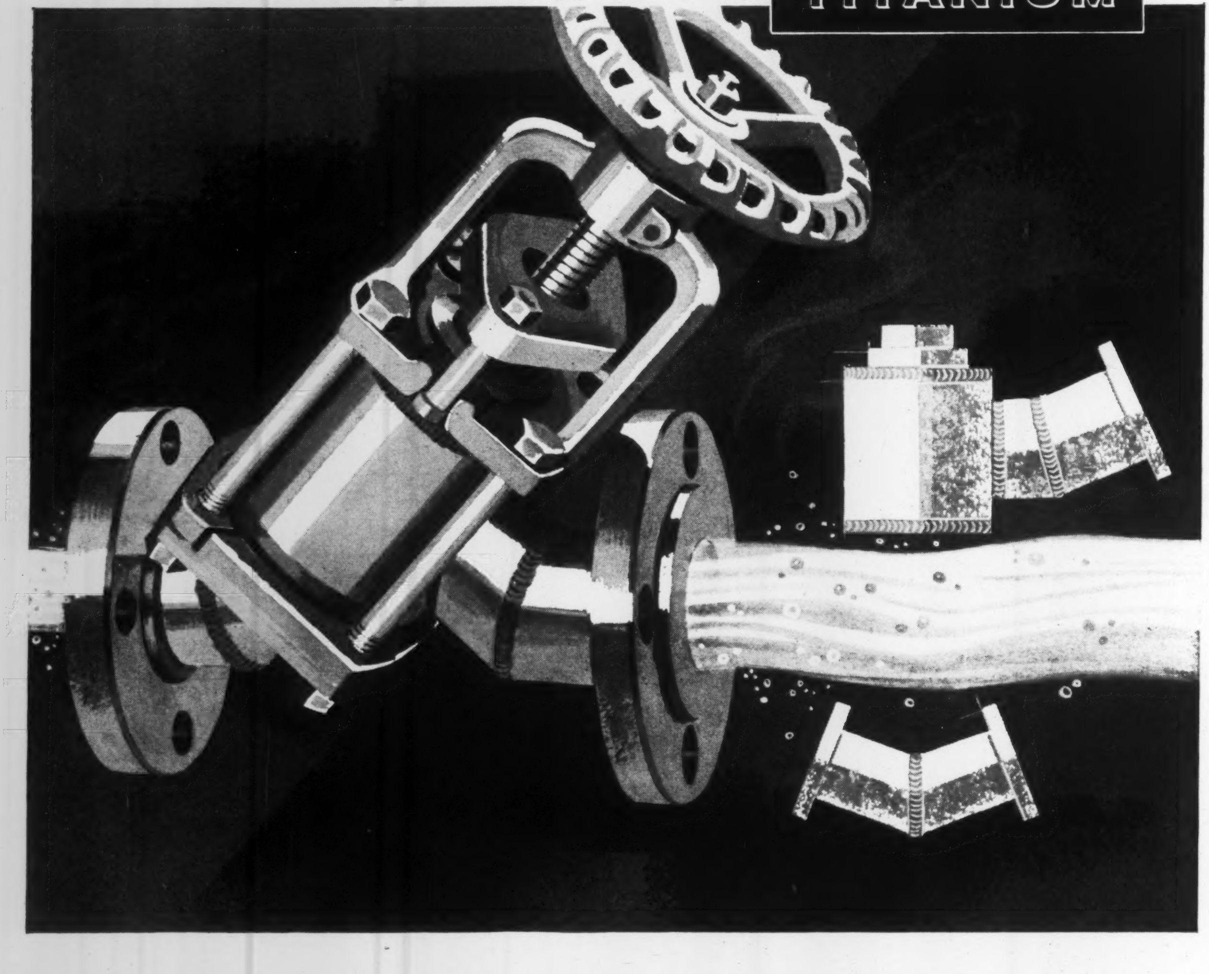
Another practical application for **TITANIUM**



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In the Durco Type K "Y" valve, shown above, *all metal parts in contact with corrosive solutions are Mallory-Sharon titanium.* Mallory-Sharon engineers worked closely with Duriron designers on welding and forming techniques for the new valves. Mallory-Sharon titanium mill products are also being used in a Durco plug valve and a new line of corrosion resistant "Durcopumps".

For help in applying titanium's unusual corrosion resistant properties to *your* processing equipment, write for Technical Data Sheet on *Titanium Valves for Chemical Service.* Please address: Commercial Market Development, Department B, Mallory-Sharon Metals Corporation, Niles, Ohio.

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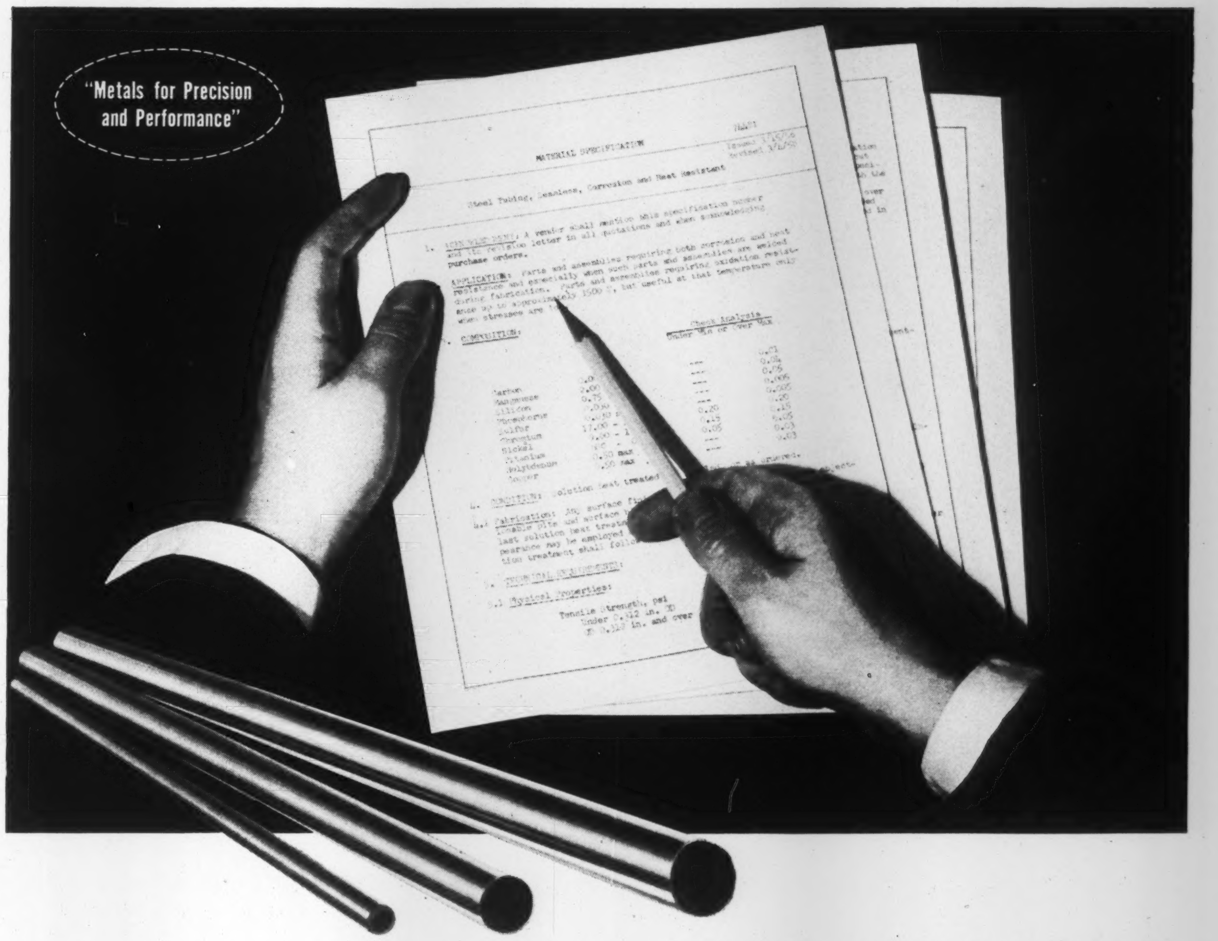

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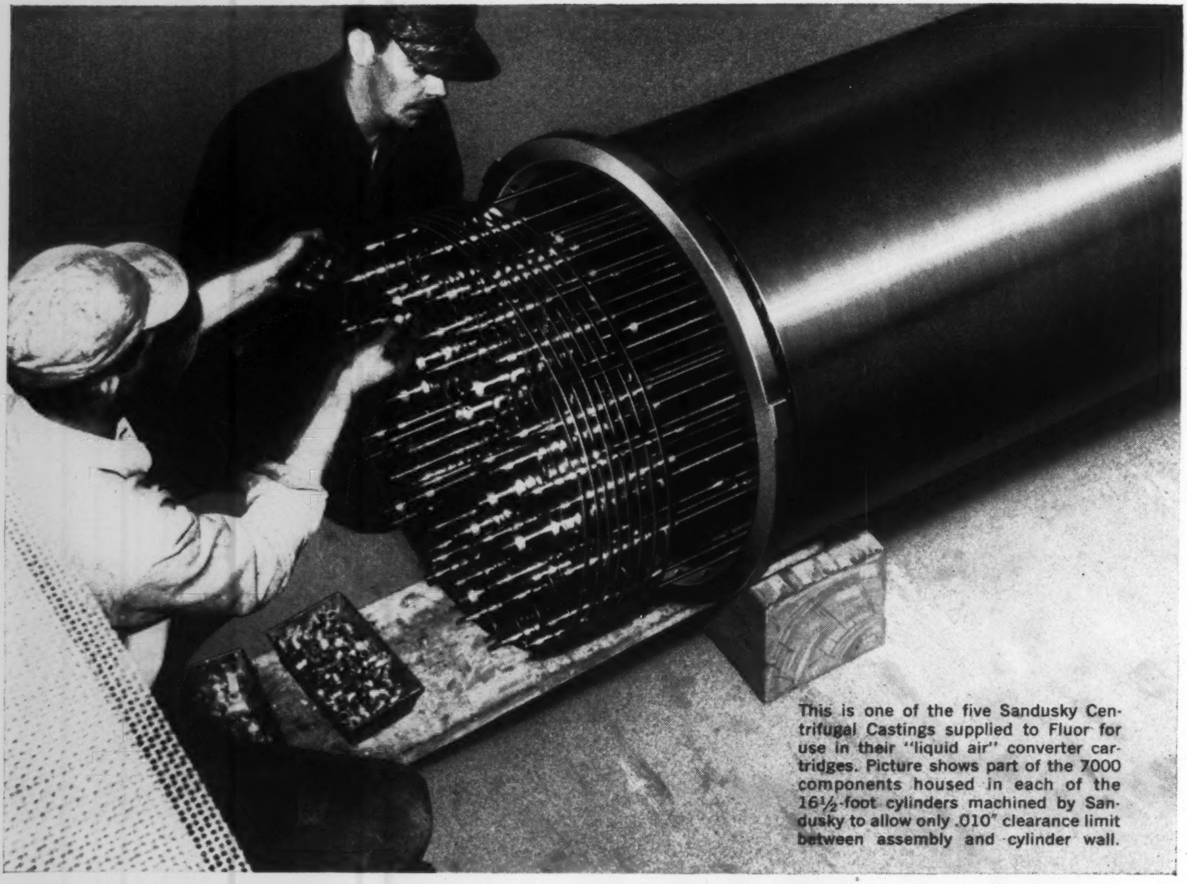

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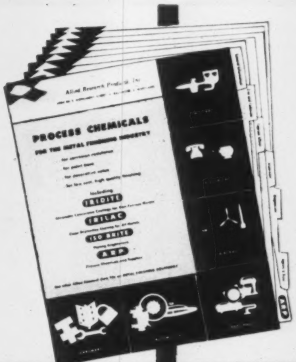

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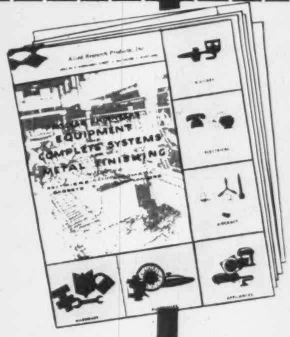
IRILAC™ Clear Protective Coatings for All Metals.

ISOBRITE® *Chemically Different* Plating Brighteners.

ARP® *Process chemicals.*

EQUIPMENT AND COMPLETE SYSTEMS
for Metal Finishing

Process Engineered—Single pieces of equipment or all equipment necessary for a finishing operation—evaluated, designed, fabricated, installed and tested to match exactly your particular process. Ask about our *Process Engineering Service.*



WAGNER RECTIFIERS

Silicon and Selenium, built to exacting specifications for long life, trouble-free service.

WAGNER AUTO-LOADERS

for fast, economical transfer of racks and parts, conveyors to plating machines, between conveyors.

AUTOMATIC AND SEMI-AUTOMATIC PLATING MACHINES

BARRELS, TANKS and other equipment.

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Prompt service on a wide variety of daily-use necessities for the plating room, delivered from warehouse stocks strategically located in cities in metalworking areas.

Allied Research Products, Inc.
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FLAT • TOP® **ANODES** in copper and zinc.

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Ask your Allied Field Engineer about our Subscription Plan which combines your new nickel purchases with a service to recast *your* butts and spears, resulting in substantial savings.

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WRITE TODAY FOR COPIES of these useful files describing technical details of our complete line, OR, phone your Allied Field Engineer. He's listed under "Plating Supplies" in your 'phone book.

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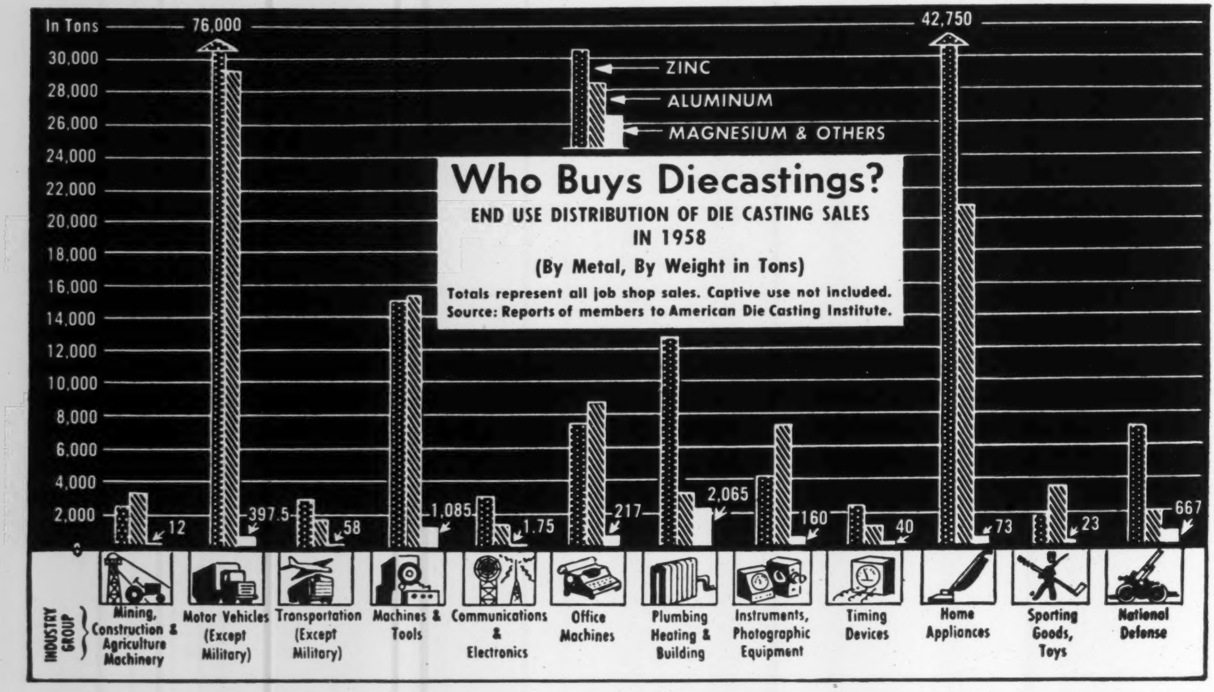

Who Buys Diecastings?

END USE DISTRIBUTION OF DIE CASTING SALES IN 1958

(By Metal, By Weight in Tons)

Totals represent all job shop sales. Captive use not included. Source: Reports of members to American Die Casting Institute.

these industries do!

Applications of zinc base die castings are steadily becoming more varied and more widespread. Today, it would be virtually impossible for anyone to go through an ordinary day's routine of living without using—directly or indirectly—an immense number of appliances, devices and services in which zinc alloy die castings form essential parts. The chart above shows sales by job shop die casters in 1958. The superior physical characteristics of zinc as a base metal for die castings is indicated by the fact that in 1958 67% of all die castings by weight, sold by job shops, were based on zinc.

Die Casting . . . the shortest distance between raw material and finished product . . . is the second largest consumer of zinc and is continuing to expand because of industry's recognition of what the process has proved itself to be: One of the fastest and most economical production techniques at the command of the metalworking industry today.

DIECASTING is the Process .. ZINC, the Metal

BUNKER HILL

The Preferred Zinc

BUNKER HILL
ZINC

BUNKER HILL 99.99+% ZINC

Eastern Sales Agents

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Sales Office For Pacific Coast

THE BUNKER HILL CO., 680 MARKET STREET, SAN FRANCISCO 4, CALIF.

ZN-139

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helping a *best seller* sell!
Superior
STAINLESS STRIP STEEL

on the *high-style* model of

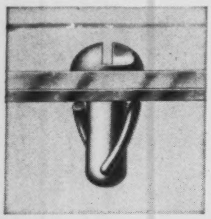
GM's no. 1 car—the beautiful Chevrolet Impala

Produced by
TERNSTEDT DIVISION
GENERAL MOTORS CORPORATION

Yes, every one of these 48 precisely-contoured *stainless steel* parts is used on the exterior body trim of the 1959 Chevrolet *Impala.* Here you see beauty, brilliance and strength that resist weather and wear without care for the life of the car—selling and re-selling at every turn. ● We are proud of Superior Stainless Strip Steel's applications in the fine automobiles of General Motors. Can we serve *your* stainless strip needs?

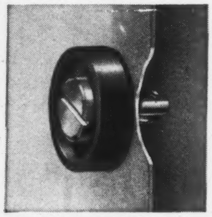
SUPERIOR STEEL DIVISION
OF
COPPERWELD STEEL COMPANY
CARNEGIE, PENNSYLVANIA
For Export: Copperweld Steel International Company, New York

How can you use SPRING-LOCK?
THE FASTENER WITH USES UNLIMITED



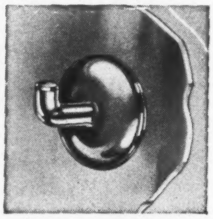
As a standard removable fastener or a blind rivet

A quarter-turn locks, unlocks. Load-carrying steel arms lock securely, don't loosen under vibration. One-piece (no receptacle) simplifies blind fastening.



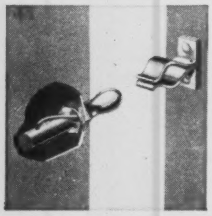
As a roller axle

Now used on range drawers, kitchen cabinets, file cabinets, desks. Cuts installation costs, saves time. Designed to suit. Available with or without roller.



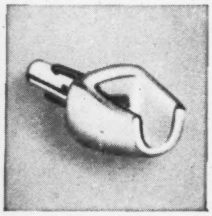
As cup hooks

High-strength polystyrene or chrome-plated die cast zinc. Inexpensive, sturdy and good-looking. Simply and quickly installed with a twist of the wrist.



As a cabinet door strike

Millions in use on kitchen cabinets, automatic dishwashers, etc. Standard strikes available from stock, or custom designed for special contour requirements.



As a plastic shelf support

. . . with the heart of steel for extra strength. Millions now used by all major refrigerator manufacturers. Complete flexibility of head design.

What is your application for

SPRING-LOCK?

Send us your application inquiries. Our engineers will answer you specifically and promptly. Or, write today for the Simmons Catalog. SPRING-LOCK samples are available upon request.

Visit us at Booth 325
1959 DESIGN ENGINEERING SHOW
Philadelphia May 25-28

SIMMONS FASTENER CORPORATION

1759 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • ROTO-LOCK LINK-LOCK • DUAL-LOCK

SEE OUR 8 PAGE CATALOG IN SWEET'S PRODUCT DESIGN FILE

For more information, turn to Reader Service Card, circle No. 378

For more information, Circle No. 487 ➤

ABRASION PROBLEMS?

To get down to hard facts—Coors Space Age Ceramics are among the hardest common materials known! They are harder than silicon carbide and are comparable to sapphire, having a hardness rating of 9 on Moh's Scale and a Knoop Hardness Factor of 1450 to 1750.

This means that if abrasion is likely to cut short the service life of the part you are designing, it will pay you to consider using Coors High Alumina Ceramic.

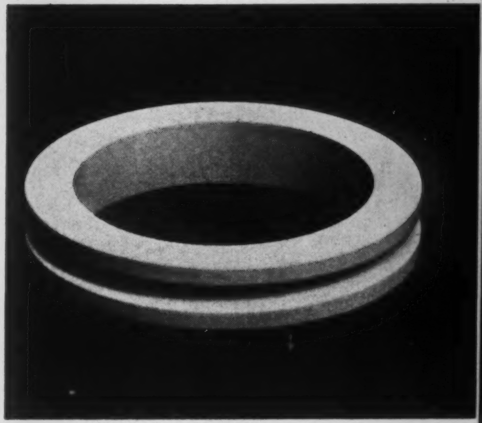
Of course, it is the extreme hardness and toughness of Coors Aluminas that provide superior resistance to wear and abrasion. But just as important in the design of a part are other properties. Coors Aluminas have outstanding mechanical strength—up to 34,000 psi tensile strength and over 300,000 psi compressive strength. They have permanent dimensional stability, superior impact resistance, are chemically inert and they can be fabricated to extremely close tolerances. Typical applications:

Seal Rings

Mechanical rotary seals are fast replacing the conventional stuffing box and packing gland in preventing leakage of liquids along the rotating shafts of pumps, agitators and similar equipment—abrasive applications as tough as they come.

Many thousands of these seal mechanisms are now being made with Coors High Alumina Ceramics as one of the two seal surfaces—the other surface being a graphite composition or a plastic such as nylon or teflon. Under special conditions, with pressures below 25 psi, an exceptionally good seal is obtained by running ceramic against ceramic—possibly because lapped surfaces can be made on the ceramic parts to 2 or 3 light bands of flatness. Most liquids act as a good lubricant because the ceramic is chemically inert.

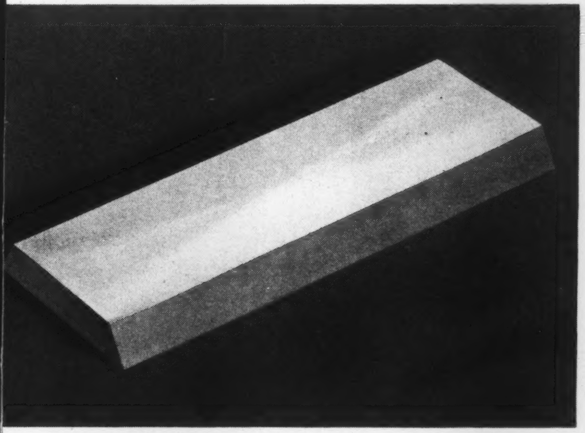
Dependability of Coors Aluminas in seal rings is demonstrated by the fact that they are widely used with radioactive or toxic material.



MECHANICAL SEAL RING

Standard Production Tolerances
Coors Ceramic Seal Rings

Flatness—Running Face ground and lapped to 3 light bands.
Parallelity of faces—within .002" T.I.R.
Concentricity—.005" T.I.R.
Outside Diameter—±.005"
Thickness—±.005"



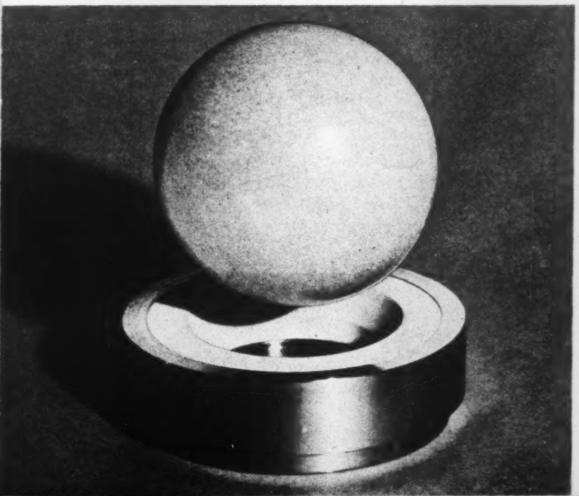
WEAR PLATE after 4½ months of service life, shows only slight wear. This Coors Ceramic plate replaced a plate of hardened tool steel which lasted only two days.

Wear Plates

Because of the extreme hardness of Coors High Alumina Ceramics, even swarf consisting of cutting oil, aluminum oxide cutting wheel grit and steel cuttings has little effect in cutting or abraiding parts made from the ceramic. This wear plate, for example, on a Production Centerless Belt Grinder was originally hardened tool steel. In grinding a .015" cut in steel tubing for precision hydraulic cylinders, grooves .05" deep were worn in the steel wear plate by the swarf in only two days, causing a loss of the required grinding tolerance. Now, made of Coors High Alumina Ceramic, wear in 4½ months has amounted to only .01"—the same wear put on the steel plate in a few hours!

Other applications range from oil field uses for metering chokes, mud gun nozzles and rock bit nozzles all the way to nose cones for missiles.

BALL TYPE CHECK VALVE



Ball Type Check Valves

Replacement of metal valve seats with Coors High Alumina Ceramic provides improved operation of filter press pumps. Metal seats previously used have lasted as little as three weeks in service. Valve seats made by Coors, inspected after months of service, show no sign of wear.

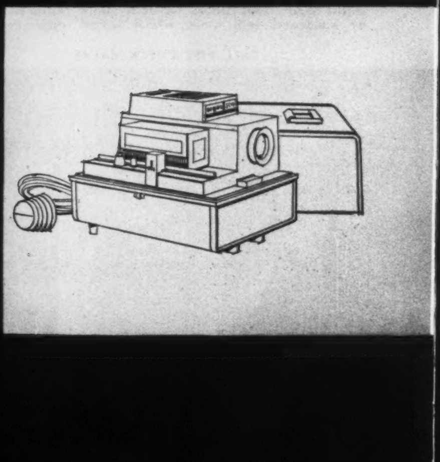
This is typical of applications where abrasive slurries are being controlled with ball type check valves using Coors Ceramic. For best results, both a Coors ceramic ball and seat are used. Coors Ceramic is chemically inert, so this type of valve is also useful for acid or some alkali applications. (Spherical ground balls of Coors AD-85 Ceramic are kept in stock. Special tolerances on balls extend up to ±0.000020".)

Coors offers a complete engineering service to assist you in utilizing these high strength ceramics to the best advantage. For complete properties and specifications, write for Bulletin 858.

See you at the Design Engineering Show Booth 603

Coors
COORS PORCELAIN COMPANY
600 Ninth Street, Golden, Colorado

Shaping the



Design by Harley Earl Associates
Arvinyl and fabrication by Arvin Industries, Inc.

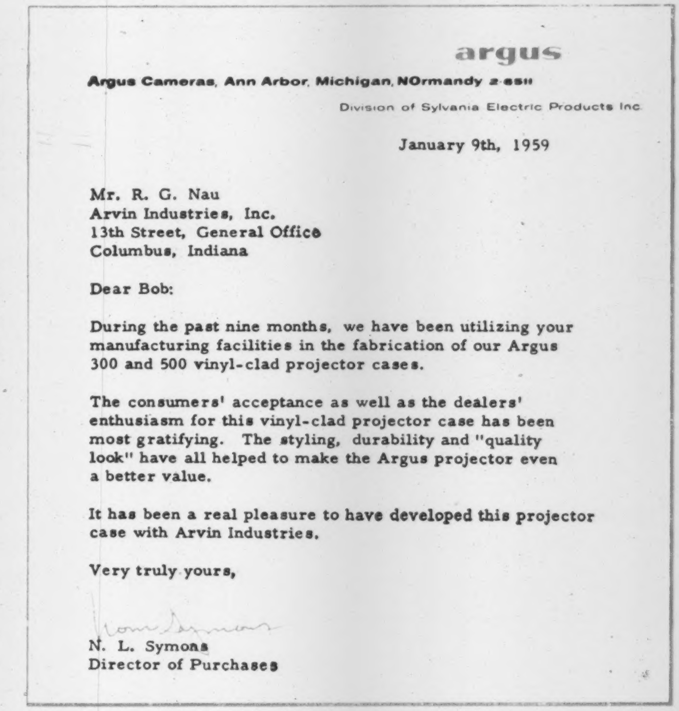
new world of product design

ARVINYL

ARVINYL is a highly versatile new metal laminate which affords designers vast opportunity to improve product life and looks. And Arvin's "one-stop" fabrication facilities assure superior quality, virtual elimination of trim scrap, and notable economies in tooling and labor costs.

We can laminate both sides of metal, deep draw Arvinyl into almost any form, and spot weld it by magnetic force to metal of lighter or heavier gauge without marring the vinyl surface. An especially interesting Arvin development is the Aluma-Lok* technique used in making the Argus projector case.

For working with designers, Arvin maintains a prototype department and a plastic tool and die shop for building mockups. We invite you to bring to our consulting staff, without obligation, any projects which contemplate new design. For descriptive Arvinyl brochure, write to Dept. AM59.



argus

Argus Cameras, Ann Arbor, Michigan, NOrmandy 2-6511

Division of Sylvania Electric Products Inc.

January 9th, 1959

Mr. R. G. Nau
Arvin Industries, Inc.
13th Street, General Office
Columbus, Indiana

Dear Bob:

During the past nine months, we have been utilizing your manufacturing facilities in the fabrication of our Argus 300 and 500 vinyl-clad projector cases.

The consumers' acceptance as well as the dealers' enthusiasm for this vinyl-clad projector case has been most gratifying. The styling, durability and "quality look" have all helped to make the Argus projector even a better value.

It has been a real pleasure to have developed this projector case with Arvin Industries.

Very truly yours,

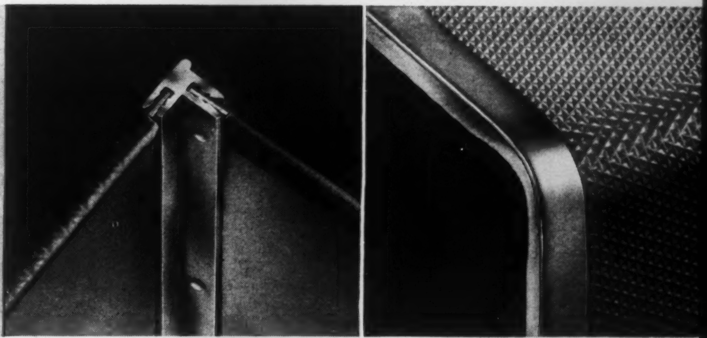
N. L. Symons
Director of Purchases

Arvinyl Division, Arvin Industries, Inc., Columbus, Indiana

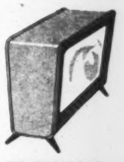
*Patent applied for

NEW ARGUS PROJECTOR CASE

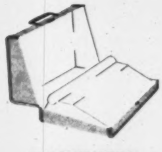
Two-channel aluminum frames, extruded by Arvin, are applied in the flat to two edges of the wrap-around section, which is then formed by Arvin's Aluma-Lok* technique. End pieces are slipped into channels and mechanically locked into place. Interior is painted, latches and plastic handle (also made by Arvin) are applied and the case is complete. Tooling is simple and there is virtually no trim scrap. Result: A better-looking, better selling case, with greatly improved resistance to damage—and produced at lower cost than the previous pyroxylin-covered wood case.



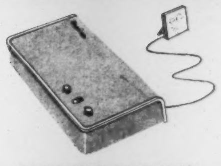
Aluma-Lok* is ideally suited to almost any type of cabinet or enclosure for products such as:



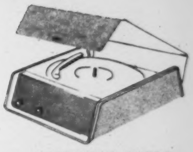
TELEVISION



TYPEWRITERS



DICTATING MACHINES



RECORD PLAYERS

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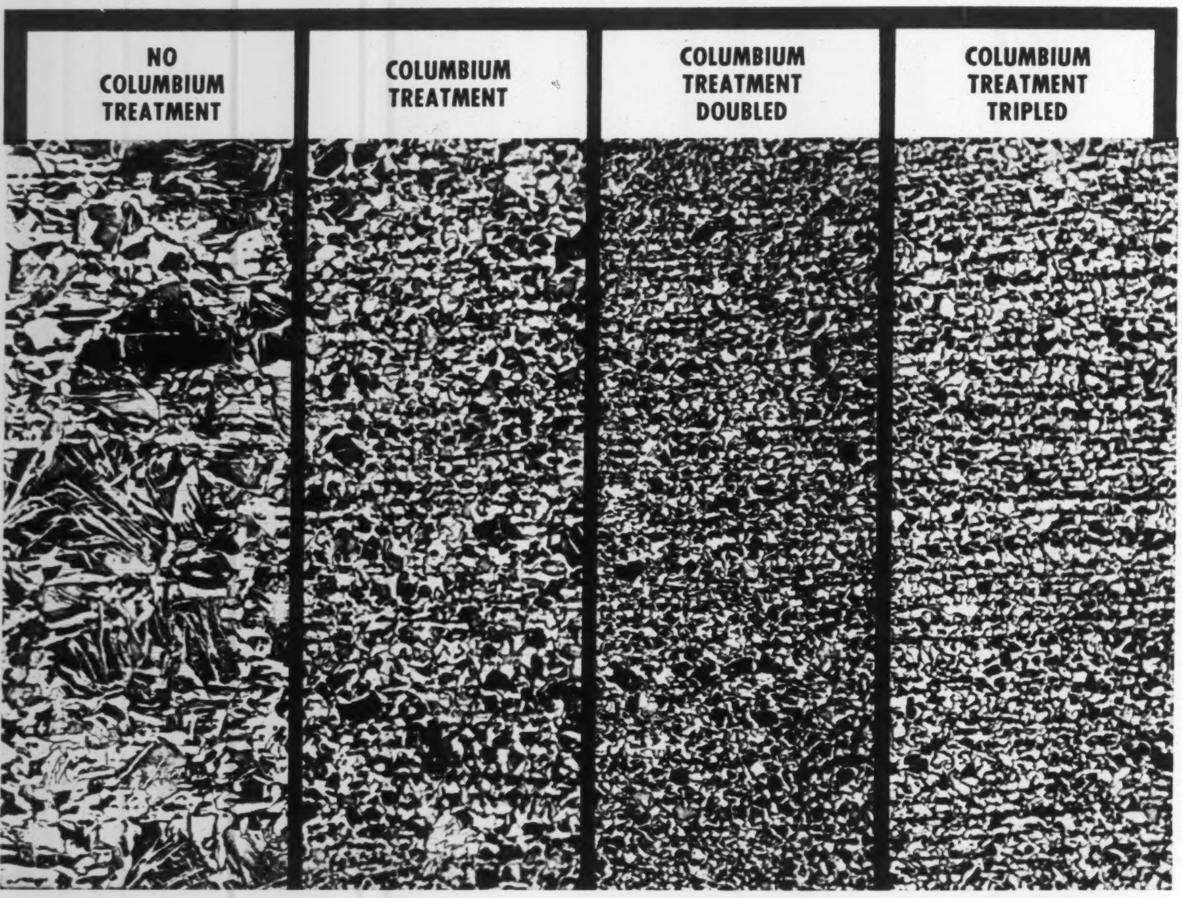
HOW GREAT LAKES


NO COLUMBIUM TREATMENT
COLUMBIUM TREATMENT
COLUMBIUM TREATMENT DOUBLED
COLUMBIUM TREATMENT TRIPLED

Composite of photomicrographs made from the same heat of mild carbon steel shows the effect of varying columbium treatments on the grain structure of the steel.

The Great Lakes Family of High-Strength Steels

N·A·X
FINEGRAIN STEEL

Lets you design superior performance, longer life and less weight into your product. Many diversified applications.

N·A·X
HIGH-TENSILE STEEL

Offers all the characteristic features of N-A-X Finegrain, plus greatly enhanced resistance to atmospheric corrosion.

GLX W

A series of fine grained, mild carbon steels. They have unusually high strength, toughness and weldability.

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N·A·XTRA STEELS

Quenched and tempered steels of excellent weldability and toughness, with yield strengths from 75,000 - 110,000 psi.

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HIGH MANGANESE STEELS

N-A-X High Manganese and High Manganese Special Killed. These steels give yield strengths up to 50,000 psi.

STEEL CORPORATION'S NEW GLX-W STEELS GIVE . . .

HIGH STRENGTH

TOUGHNESS

REDUCED COSTS

Key to the success of Great Lakes' new GLX-W Series of steels is the fine grained internal structure produced by treatment with columbium. This grain refinement also contributes to ductility. And in addition, the GLX-W Series' low carbon and manganese content assures excellent weldability with freedom from underbead cracking under all conditions.

COST AND WEIGHT SAVINGS

Where design permits the replacement of carbon steel with GLX-W steels, weight savings of 20 to 35 per cent, and cost savings of 10 to 25 per cent can be realized. When replacing alloy steels the cost savings can range from 25 to 35 per cent. These steels feature higher yield strengths, greater tensile strengths and increased toughness without costly heat treatments or extensive alloy additions.

The GLX-W Series is so priced that substantial cost reductions can be obtained by weight reduction over mild carbon steel. Cost reduction can also be obtained over alloy steels because of the lower price of GLX-W steels.

MANY USES FOR GLX-W STEELS

GLX-W steels are especially recommended for a broad range of applications in mobile equipment and pressure vessels, as well as the transportation and construction fields.

STRONGER AND TOUGHER

GLX-W steels are stronger and tougher than ordinary mild carbon steels and in some applications can do the job now being done by the more costly alloy steels.

GLX W

For additional technical information about these economical GLX-W steels write

Product Development Division, Dept. D-1
GREAT LAKES STEEL CORPORATION
Detroit 29, Michigan • Division of
NATIONAL STEEL CORPORATION

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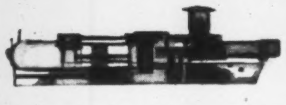
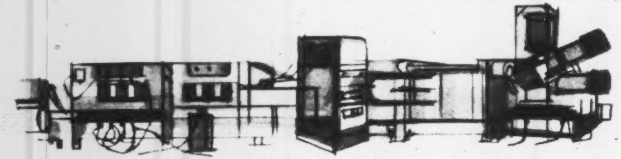
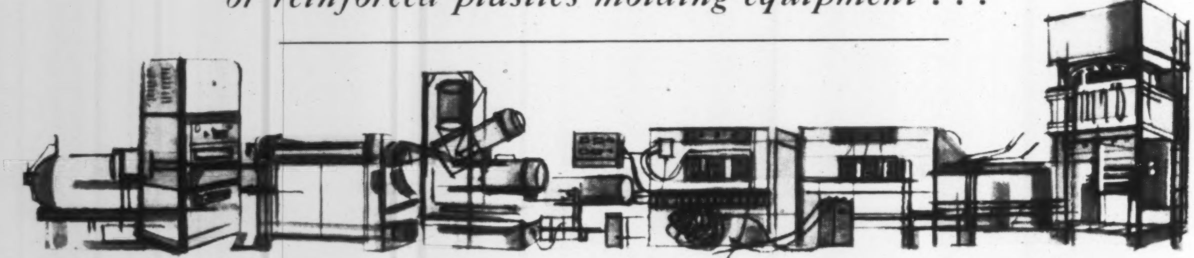


Hundreds of plastic molders have presses for one or two types of molding . . .



some have vacuum forming, extrusion, compression, injection or reinforced plastics molding equipment . . .



But only one has more equipment . . . in more types . . . and more sizes . . . than anyone else in the world!

GENERAL AMERICAN
Plastics Division

General American's Plastics Division offers you advantages that no other molder in the world can match!

- The largest and most varied molding facilities in the industry, with compression presses up to 2000 tons for regular and reinforced plastics in simple and complex shapes, injection presses up to 300 ounces, and large extruding and vacuum-forming machines.
- An experienced staff of research and development specialists, and a complete engineering department.
- Modern tool and die shops.
- A continuing advisory service, including a Customer Service Manager assigned to live with your job through every step of production.

These are some of the reasons why General American is the nation's leading custom molder of plastics. Let us study your products to help you determine whether the use of custom molded plastics will improve them. You'll find . . . *it pays to plan with General American.*

Plastics Division
GENERAL AMERICAN TRANSPORTATION CORPORATION
135 South LaSalle Street, Chicago 90, Illinois
Offices in principal cities

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The Legendary Firebird, the Phoenix, rose young and strong again and again from flames . . . This is the new Norton Firebird — symbol for the exciting new fused materials made in Norton's electric furnaces.

NORTON electrochemicals
. . . gifts of the firebird

CARBIDES: gifts of the Firebird

Roaring flames gave the legendary Phoenix the power to range over wide areas of earth, sea, and sky. Similarly, the white-hot fury of modern electric furnaces is Norton's source of power in making carbides of boron, silicon, titanium, and zirconium for an amazing range of applications.

For example, boron carbide, a starting point for high energy rocket fuels . . . zirconium carbide, today's highest melting point material available in tonnage quantities . . . titanium and silicon carbide, key metallurgical additives.

They have gained importance as rich chemical source materials . . . as metallurgical additives . . . as high temperature electrical conductors and resistors . . . and as refractories and cermet components.

Explore the dynamic possibilities of Norton carbides as economical, high-efficiency materials for your processing requirements. Get the fact-filled booklet *Norton Electrochemicals . . . Gifts of the Firebird*. Write NORTON COMPANY, Electro-Chemical Division, 952 New Bond Street, Worcester 6, Mass.

NORTON

ELECTROCHEMICALS

Gifts of the Firebird: compounds of silicon • zirconium • boron • aluminum • magnesium • titanium • chromium . . . including many borides • carbides • nitrides • oxides

MAKING BETTER PRODUCTS . . . TO MAKE YOUR PRODUCTS BETTER

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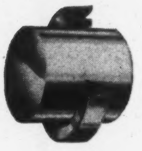
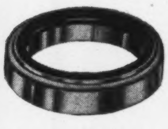
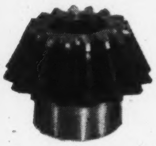
VALUE ANALYSIS where it really counts
. . . during design!


C/R Shaft Type Oil Seal


C/R Standard End Face Seal

C/R Sirvene Diaphragm

C/R Sirvis Molded Cup


C/R Rawhide Beveled Gear

Here's an expert at work, saving you money at the right time — during design. Like all C/R sales engineers, he's an experienced, well-trained representative whose knowledge springs from a solid engineering background. His ability to sit down with you during the design phase will help develop the most efficient and economical solutions to your problems.

For example, he will often suggest design modifications that may save substantial production costs. Again, he will advise against specifications or seal types which he knows from experience will lead to service problems and user dissatisfaction. His personal "value analysis" of your fluid sealing problems, backed by the quality of these Chicago Rawhide products, can save you money. Welcome him when he calls to see you.

CHICAGO RAWHIDE MANUFACTURING COMPANY
1227 ELSTON AVENUE • CHICAGO 23, ILLINOIS
Offices in 55 principal cities. See your telephone book.
In Canada: Manufactured and Distributed by Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario.
Export Sales: Geon International Corp., Great Neck, New York

C/R
CHICAGO
RAWHIDE

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FORMICA®
Laminated Plastic
die stock
S-52

light weight die stock = lower cost metal forming

FIF

FABRICATOR OF INDUSTRIAL FORMICA LAMINATED PLASTICS

New Field Fabricating Service

Now fabricated parts delivered on Streamliner schedule—in 24 hours in some cases—from your local Fabricator of Industrial Formica laminated plastic. He serves you better with:

1 Faster delivery

2 Highest quality

3 24-hr. delivery on standard Formica sheets and rods

FI-2096

Formica® S-52 die stock is half the weight of aluminum . . . gives you more metal forming surface per dollar. Has excellent machining qualities, can be fabricated faster and less costly than metal. Its strength/weight ratio is greater than steel, it has eight times the dent resistance of hard maple. Its smooth surface forms metal without surface irregularities.

S-52 is the perfect material for templates, stretch forming, hydro-press forms, metal spinning chucks, pattern boards . . . for drill and gluing jigs . . . for structural uses in aircraft, cars and boats. Your local Fabricator of Industrial Formica laminated plastic will fabricate your S-52 parts in record time. Send today for the name of your fabricator and free S-52 bulletin, form 872. Formica Corporation, a subsidiary of American Cyanamid, 4550 Spring Grove Ave., Cincinnati 32, Ohio.

FORMICA® Laminated Plastic *a product of* CYANAMID

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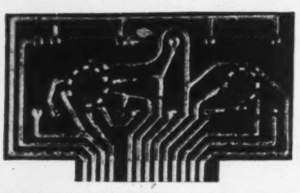
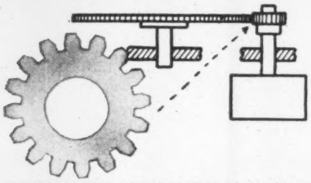
For your toughest insulating problem, choose from the industry's widest range—

CDF DILECTO®

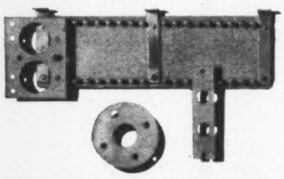
glass-base laminates



SPEED AUTOMATIC PRODUCTION of printed circuits with warp-resistant C-D-F metal-clad Teflon* and epoxy laminates. Other advantages: high bond strength of copper to laminate, superior blister-resistance in solder immersion.



HIGH-VOLTAGE (1800v.) RF ISOLATION is achieved by miniature C-D-F Dilecto gears in an aircraft receiver-transmitter switch. They also had to exhibit dimensional stability through a wide temperature range, resistance to fungus growth and thermal shock.



PRECISE MACHINING AND FABRICATION are standard benefits of Dilecto laminated plastics. These silicone glass-base parts (coil mountings, aircraft terminal board) were sawed, drilled, punched, and milled in production quantities by C-D-F and customer.

Teflon*, silicone, epoxy, melamine, and phenolic glass-fabric laminates. Polyester glass-mat laminates.

You can improve design, speed production, and save money by specifying one of the many C-D-F Dilecto grades. Whatever your application for these laminates — with fine- or medium-weave glass-cloth base — you'll find a better answer to your problem at C-D-F. (Melamine can also be made with glass-mat base.) And C-D-F offers modern machining and fabrication facilities to deliver production quantities of finished Dilecto parts to your specifications.

See our catalog in Sweet's Product Design File, where the phone number of your nearby C-D-F sales engineer is listed. For free trial samples of glass-base Dilecto, or of any other C-D-F plastics, mica, or fibre product, send us your print or your problem! Write for your free copy of C-D-F Technical Bulletin 64.

*DUPONT TRADEMARK FOR TETRAFLUOROETHYLENE RESIN

PROPERTIES OF SOME TYPICAL C-D-F DILECTO GLASS-BASE GRADES

Grade	Equivalent NEMA or ASTM grade	Flexural Strength Lengthwise (PSI)	Dissipation Factor at $10^{6\sim}$ Cond. A	Dielectric Strength Parallel Step x step	Insulation Resistance Cond. C96/35/90	Arc Resistance (seconds)	Maximum Operating Temp. (°C.)
GB-112T (Teflon*)	None	14,000	0.0015	65	100,000	180 +	250
GB-12S (Silicone)	G-7	28,000	0.002	60	100,000	180+	200
GB-28E (Epoxy)	G-10	70,000	0.019	65	75,000	130	150
GB-28EFR (Flame-Retardant Epoxy)	G-11	68,000	0.010	65	100,000	180	150
GB-28M (Melamine)	G-5	50,000	0.014	50	100	185	135
GB-261D (Phenolic)	G-1 and G-2	22,000	0.020	55	10,000	5	150
GM-PE (Polyester)	GPO-1	35,000	0.020	70	200	130	150

These are typical grades for typical applications. To meet special requirements, C-D-F makes many other Dilecto grades, one of which may serve your purpose better than any of these listed here. Consult the C-D-F Technical Department for expert assistance with your design problem involving laminated plastics products.

CONTINENTAL-DIAMOND FIBRE

A SUBSIDIARY OF THE Budd COMPANY • NEWARK 25, DELAWARE

For more information, turn to Reader Service card, circle No. 427

410
with
T^nCP

NOT GETTING PREMIUM PERFORMANCE?

Switch to 410 with T^nCP*

If you're dissatisfied with your casting shop performance; if your reject rate is high, analyses and properties variable and unpredictable, you may need only a switch to PREMIUM materials.

For a manufacturing operation of any type can be compared to automobile performance and gasoline mileage figures — YOU GET PREMIUM PERFORMANCE IF YOU USE PREMIUM MATERIALS!

Unlike the automobile fuel analogy, you NEED NOT PAY PREMIUM PRICES to get PREMIUM PERFORMANCE from your casting alloys. Simply SPECIFY RxMET CERTIFIED ALLOYS for all your STAINLESS STEEL, TOOL STEEL, SUPERALLOY and VACUUM-MELTED ALLOY NEEDS!

410 with T^nCP is a good example! If you are having trouble casting 410 Stainless, take advantage of the advanced thinking at WaiMet. T^nCP — a clever additive that cleans the melt without changing the analysis will help bring better casting performance to your operation.

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more than steel shot with a good additive

410 with T^nCP*

— a symbol of advanced thinking at WaiMet — advanced technology that means you get —

- CLEANER MELTING
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STAINLESS STEEL • TOOL STEEL •
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T^nCP* —a thinly disguised name for a clever additive that cleans melts without changing analysis! It means The nearly Complete Protection!

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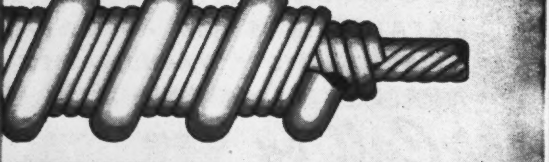
How NS solved another special wire problem



REMOTE CONTROL cable for jet aircraft is made of layers of high-tensile National-Standard wire wound around a stranded core. Heavy outer wire provides helix or worm-gear surface for meshing with hobbed wheels.

Photo courtesy Pan American Airlines

Special National-Standard wire helps fly new jet-liners

When the age of commercial jet transportation in the U.S. began last January, giant jet-liners inaugurated flights across the country at speeds over 600 mph. To control these new aircraft swiftly and easily requires control cables of the utmost reliability, efficiency and endurance.

NEW COMMERCIAL JET-LINERS, as well as many military aircraft, are flying now with a unique remote control cable system made of special high-tensile wire wound around a stranded core with a heavy outer wire of stainless steel wound to a pitch of 10 per inch. This outer wire acts as a helix to engage hobbed wheels within the various system control boxes.

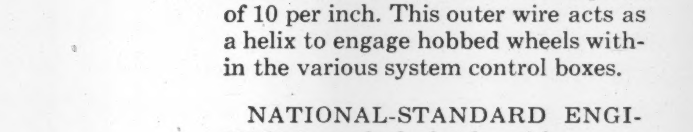
NATIONAL-STANDARD ENGINEERS worked closely with a control-cable system manufacturer to develop wire of just the proper alloy and rugged physical properties required to withstand extreme temperature and flight stress variations. National-Standard submitted wire samples to microstructural studies and physical tests to assist the customer in determining the conditions that would allow bending cable around pulleys without giving a permanent set to the cable. In addition, alloy steels with various coatings were tested to improve wear and galling resistance for various applications. The result was the development of a special stainless-steel wire that exceeded rigid specifications.

EXPERIENCED ENGINEERING HELP, of this kind, for jobs requiring high-quality wire to meet special or unique applications, is available to *you* from National-Standard. For any of the many thousands of applications where only special wire will solve the problem, let National-Standard engineers go to work for you. Write for additional information to National-Standard Company, Niles, Michigan.

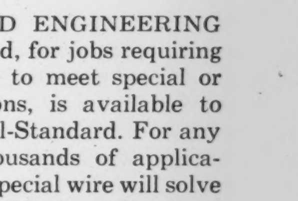
Manufacturer of specialty wire and metal products

NATIONAL STANDARD

DIVISIONS: NATIONAL STANDARD, Niles, Mich.; tire wire, stainless, music spring and plated wires • **WORCESTER WIRE WORKS,** Worcester, Mass.; high and low carbon specialty wires • **WAGNER LITHO MACHINERY,** Secaucus, N. J.; metal decorating equipment • **ATHENIA STEEL,** Clifton, N. J.; flat, high-carbon spring steels • **REYNOLDS WIRE,** Dixon, Ill.; industrial wire cloth • **CROSS PERFORATED METALS,** Carbondale, Pa.; decorative, commercial, and industrial perforated metals.



FLEXIBLE CABLE engages accurately with specially hobbed wheels housed in control boxes. This combination requires special cable wire that will not take permanent set and will provide smooth, hard bearing surface for cable inside conduit.



NATIONAL-STANDARD engineers made intense microstructural and tensile studies of sample wire to find exact physical properties of the alloy to meet strict aircraft control specifications.

For more information, turn to Reader Service card, circle No. 408

DESIGNING WITH ALUMINUM

NO. 30

This is one of a series of information sheets that discuss the properties of aluminum and its alloys with relation to design. Extra or missing copies of the series supplied on request. Address: Advertising Dept., Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago 11, Illinois.

ALUMINUM IN LOW TEMPERATURE APPLICATIONS

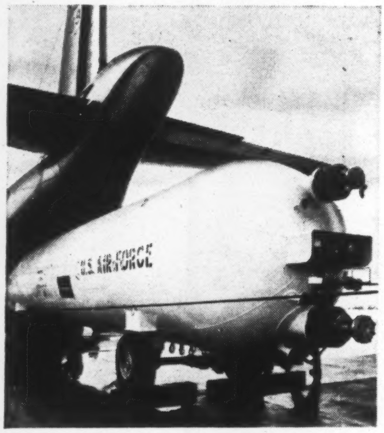
THE STRUCTURAL QUALITIES of aluminum and its alloys are actually improved at ultra-low levels of temperature, such as are encountered in the manufacture and handling of liquid gases. Tensile and yield strengths rise markedly, and percentage of elongation increases. As the lowest-cost metal capable of performing satisfactorily at temperatures below −150°F., aluminum is thus valuable to the rapidly expanding field of cryogenic applications.

Aluminum alloys also are unique among commercial metals in their combination of high strength-weight ratio, corrosion resistance, formability, weldability, reflectivity, and conductivity of heat and electrical energy. Also important for purposes of handling volatile liquids, aluminum is non-sparking, non-magnetic and non-toxic.

The requirements of commercial gas applications are filled chiefly by four industrial gases (see Figure 1). Oxygen, nitrogen, argon and helium—in that order of volume—comprise much the greater portion of commercial gas manufacture. Oxygen, nitrogen and argon are among the gases that are produced by liquefying air at −320°F. to effect a separation of each gas at its individual boiling point as a liquid. Equipment for this production can use, and has used, large quantities of aluminum alloy sheet, plate, extrusions, tubing and pipe.

These gas products, along with natural gas (mostly methane) are reduced by cooling and liquefaction to volumes only about 1/600 to 1/800 of their gaseous volume. *And because consumption by industry in both old and new applications currently amounts to hundreds of millions of cubic feet annually,* this reduction in handling bulk is of immense economic importance.

One of the latest military missiles, for example, consumes 420 cubic feet of liquid oxygen . . . 336 thousand cubic feet as gas . . . in a 90-second firing period. These liquefied gases may be stored and moved in aluminum alloy double-shelled insulated tanks, thus taking advantage of their extreme concentration in the low-temperature liquid state.



Double-shelled mobile liquid-oxygen tank, produced with Kaiser Aluminum alloy 5086. Used in fueling missiles, this tank is being loaded for transport by air.

FIGURE 1

SOME PROPERTIES OF COMMERCIAL GASES

	BOILING POINT OF LIQUID GAS (Fahrenheit)	LIQUID DENSITY AT BOILING POINT (Lbs./cu.ft.)	GAS DENSITY * (Lbs./cu.ft.)	APPROX. VOLUME INCREASE, LIQUID TO GAS *
OXYGEN	–297	71.2	0.089	799
NITROGEN	–321	50.4	0.078	650
ARGON	–302	88.02	0.1114	770
HELIUM	–452	7.82	0.0111	700
NATURAL GAS (Chiefly Methane)	–265	25.9	0.0447	580

* Gas at normal temperature and pressure.

FIGURE 2

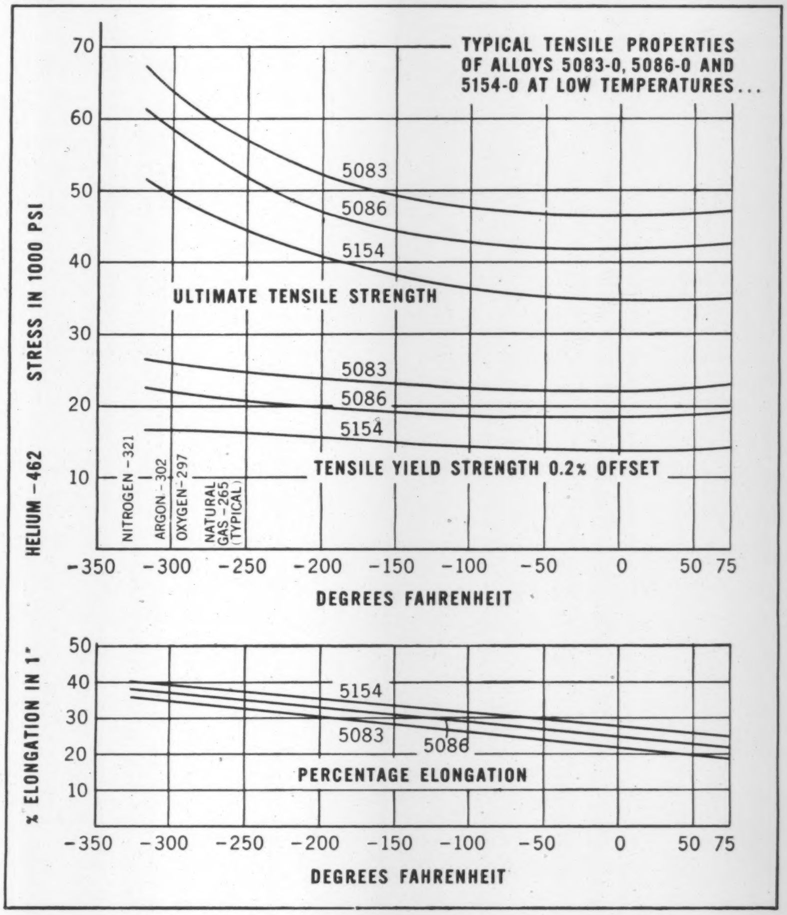
TYPICAL TENSILE PROPERTIES OF SOME ANNEALED ALUMINUM ALLOYS APPROVED BY ASME FOR UNFIRED PRESSURE VESSELS

ALLOY DESIGNATION		ASME SECTION OR CASE NO.	TENSILE STRENGTH (psi)		ASME ALLOWABLE DESIGN STRESS * VALUES (psi)	MINIMUM REQ'D WELDED TENSILE STRENGTH (psi)	PERCENT ** ELONGATION
AA	ASTM		Ultimate	Yield			
1100	990A	8	13,000	5,000	2,350	11,000	35
3003	M1A	8	16,000	6,000	3,150	14,000	30
3004	MG11A	8	26,000	10,000	5,650	23,000	20
5050	G1A	8	21,000	8,000	4,000	18,000	24
5052	GR20A	8	28,000	13,000	6,250	25,000	25
5154	GR40A	1174	35,000	15,000	7,350	30,000	27
5086	GM40A	1222	38,000	17,000	8,700	35,000	22
5083	GM41A	1247	42,000	21,000	10,000	40,000	22

* For metal temperature not exceeding 150°F.
** In 2 inch flat 1/16" gauge specimen at 75°F.

Nominal chemical compositions:
5154—Magnesium 3.5%, Manganese 0.05%, Chromium 0.25%
5086—Magnesium 4.0%, Manganese 0.45%, Chromium 0.15%
5083—Magnesium 4.45%, Manganese 0.75%, Chromium 0.15%

FIGURE 3

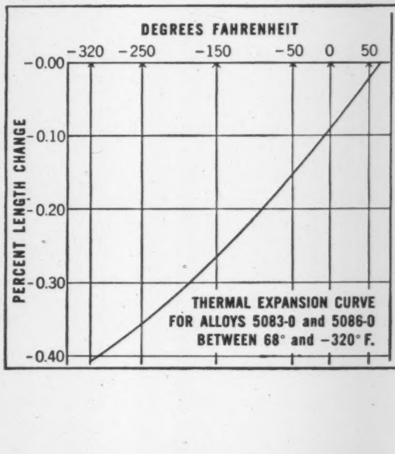


Several weldable aluminum alloys have been approved by the American Society of Mechanical Engineers as safe and suitable for construction of unfired pressure vessels such as are used in the handling of liquid gases.

Figure 2 tabulates typical tensile properties and the design stresses permitted by the ASME Code for some of these alloys, including high strength aluminum-magnesium compositions. All values shown are for metals in the annealed state. Kaiser Aluminum alloys 5083 and 5086 are the strongest ASME-approved aluminum-magnesium-manganese alloys that can be fabricated into these welded vessels by all normal methods, without need for stress-relieving or annealing. Both of these Kaiser alloys 5086 and 5083, when welded with 5183 filler, also meet the stringent "2T" bend test requirements for welds established by ASME for most other materials in these unfired pressure vessel applications.

The allowable design stress values shown are specified by ASME as acceptable for vessels and appurtenances from 150°F. down to −325°F. These permissible values are roughly two-thirds of the minimum guaranteed yield strength of the alloy at room temperature. Since the ultimate tensile and yield strengths of aluminum alloys increase as temperatures drop, the margin of safety rises still further at liquid gas temperature levels.

FIGURE 4



THERMAL EXPANSION COEFFICIENTS OF ALUMINUM ALLOYS AT LOW TEMPERATURES

Average Coefficients of Thermal Expansion
(x 10^{-6} per degree F.)

ALUMINUM ALLOYS	68° to −200° F.	68° to −320° F.
1099	11.8	10.5
3003	11.2	10.0
5083	11.6	10.4
5086	11.6	10.4
6061	11.3	10.2
#304 Steel (Stainless)	7.7	7.4

The low temperature behavior of alloys 5154, 5086 and 5083 is exemplified approximately in Figure 3. Ultimate strengths increase by about 50% from room temperature to −320°F. Yield strengths rise by about 18%. Thus, at the −320°F. level, the yield strengths of these three high-strength alloys approximate 2¼ times the stresses allowed for pressure vessel design by the ASME Code.

Through the same temperature range, percentage elongation properties have been shown by test to increase 60% or more, reaching the magnitude of 40% elongation at −320°F.

This added strength and ductility contribute much to structural dependability against both mechanical shock and large temperature differentials in different portions of the same aluminum part or system.

The thermal contractions encountered in ultra-low temperature equipment are larger than those to be accommodated in ordinary design applications. For example, an aluminum member 25 feet long contracts by about 1¼-inch through the range from 68° to −325°F. Figure 4 shows these thermal expansion characteristics, as typified by aluminum alloys 5086 and 5083.

The low elastic modulus of aluminum also contributes to its suitability for low-temperature equipment by mitigating the adverse effects of thermal contraction. Thermal deformations cause much smaller increases or decreases of stress in aluminum parts than in equivalent stainless steel parts. The representative #304 stainless steel listed in Table 4 will contract only about 70% as much as the high strength weldable aluminum alloys, for any given drop in temperature. However, the aluminum alloys have an elastic modulus of about 10,300,000 psi, roughly one-third that of the steel. Because of this difference in elastic moduli, the stress changes resulting from thermal deformation through any given temperature change

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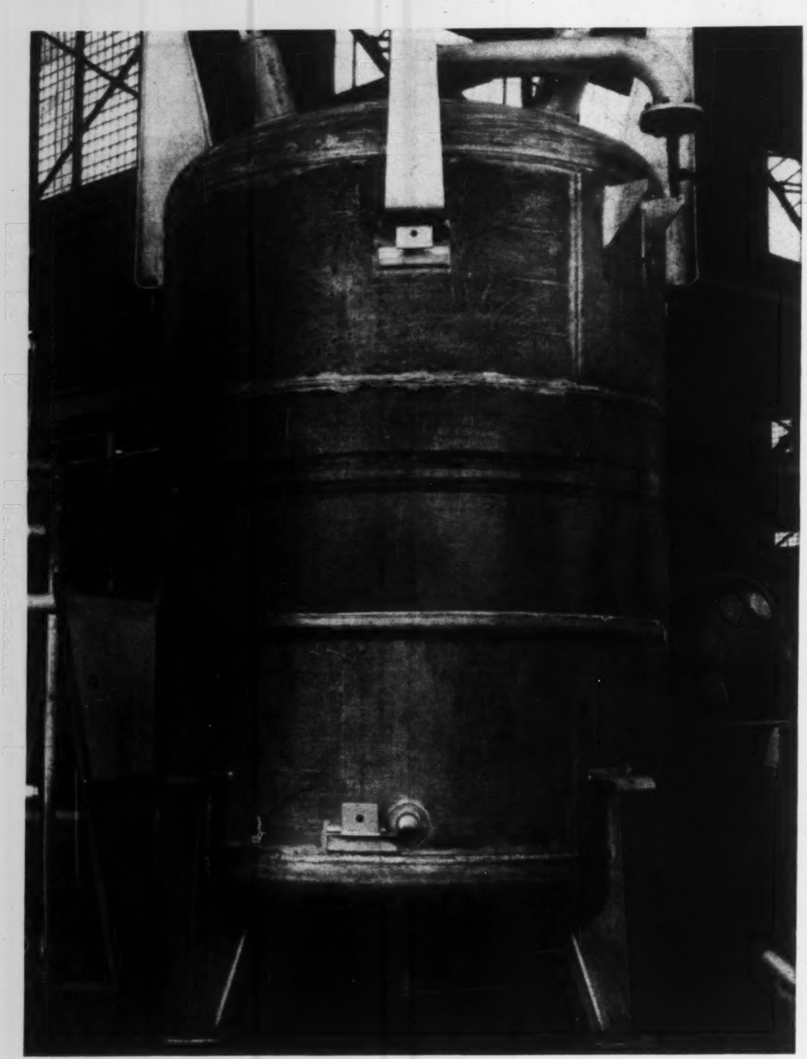


Assembly of welded aluminum vessel for a liquid-oxygen generating plant. Such plants serve the steel and chemicals industries.

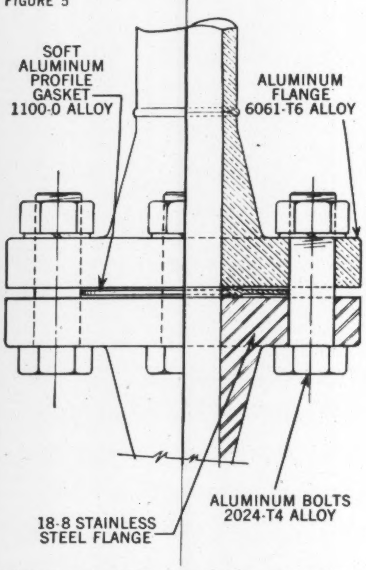
will be lower in the aluminum than in the steel.

One example of the advantages offered by this capacity for large elastic thermal deformations is the ability of aluminum alloy flanged joints, using 2024-T4 aluminum bolts, to maintain joint tightness under cyclical temperature conditions between 250°F. and −320°F. A bolt-loosening effect naturally occurs during the initial contraction of the pipe bore as it is cooled to liquid-gas temperatures, while the outer flange and the bolts remain relatively uncontracted at ambient levels. This tends to reduce gasket seating pressures. However, the loss of stress in aluminum bolts and flanges during thermal contraction of the pipe is much less than that occurring in equivalent steel parts. This ability to maintain stress during thermal deformations, along with the use of a soft aluminum profile gasket next to the bore, maintains adequate sealing while the flanges and bolts also cool. Since it often is desirable to bolt an aluminum flanged line to a stainless steel flanged line, for heat-dam purposes, this elastic property dictates that aluminum alloy 2024-T4 bolts should be used.

Metallurgical Research Data Now Available

Since most liquid-gas containers require a high vacuum between outer and inner shell to achieve the best possible insulating conditions, external pressure design charts have been developed by the Kaiser Aluminum Department of Metallurgical Research for each of the high strength alloys. These charts, and other information on aluminum use in low temperature applications, are available to interested manufacturers.

FIGURE 5


SOFT ALUMINUM PROFILE GASKET 1100-0 ALLOY
ALUMINUM FLANGE 6061-T6 ALLOY
ALUMINUM BOLTS 2024-T4 ALLOY
18-8 STAINLESS STEEL FLANGE

For immediate attention to your request for these charts and other technical information—or for engineering assistance in your own applications—contact the Kaiser Aluminum sales office listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office,* Palmolive Bldg., Chicago 11, Illinois; *Executive Office,* Kaiser Bldg., Oakland 12, Calif.

See our catalog in PRODUCT DESIGN FILE or write for copy

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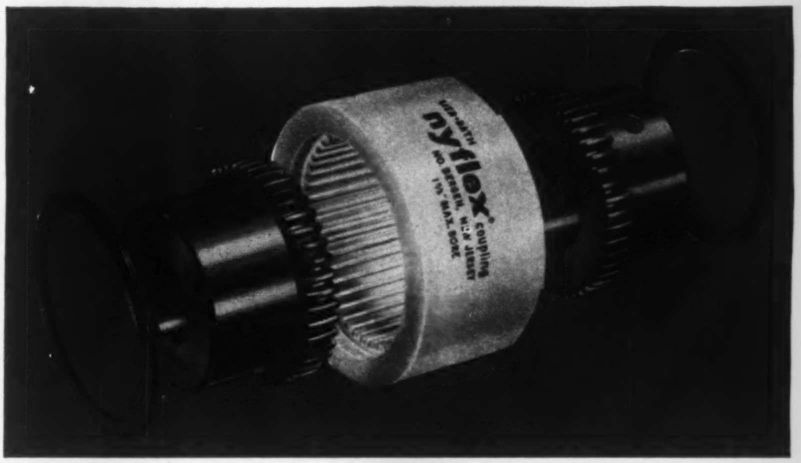
New ideas in NYLON



Sier-Bath nyflex gear coupling, with Spencer Nylon sleeve, shows . . .

"No visible signs of wear after 800 hours of continuous operation"

An amazing, new flexible gear coupling now being produced by Sier-Bath Gear and Pump Co., Inc., of North Bergen, N. J., makes highly effective use of the special properties of Spencer Nylon.

On this coupling, Sier-Bath uses a Spencer Nylon sleeve that never needs lubricating! Precision molded to mesh accurately with the metal hubs, the light weight sleeve passed a "torture test" that other plastics or metal would fail—yet the sleeve of Spencer Nylon costs far less than other materials!

There were no signs of wear on the Spencer Nylon teeth after 800 hours of testing! Connected between a pump and motor transmitting 25 hp at 1,750 rpm, the coupling was misaligned to its maximum and run for 400 hours.

Then a start-stop mechanism stopped the unit for 3 minutes every half-hour (762 starts). After 400 more hours, the coupling was removed and inspected.

The Spencer Nylon sleeve showed no wear, even though dirt, oil, water, etc. were thrown into the coupling during the test!

Because it is plastic-light and metal-strong, Spencer Nylon is being used by more and more manufacturers every day to solve material problems. You may discover that Spencer Nylon can help you find the answer to a particular problem—and cut costs at the same time!

For the names of molders who can supply you with nylon machine parts, gears and bearings, write to Spencer Nylon at the address below:

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SPENCER CHEMICAL COMPANY
GENERAL OFFICES, DWIGHT BUILDING, KANSAS CITY 5, MISSOURI

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FRASSE ALUMINUM
helps tell
how she's doing!

Ballistic missile success hinges on intelligence obtained in test firings. Tracking data – reporting velocity, direction, altitude, temperature, etc. is vital – when processed, it guides critical design changes.

Heart of the intricate data processing system at Cape Canaveral is a Potter Magnityper – a high speed electronic printer that decodes raw material . . . then stores, collates, interprets and prints at 72 *thousand* characters per minute. Lightweight, non-magnetic aluminum is essential to its efficient operation – that's why the Magnityper is made almost completely of Frasse aluminum.

Frasse ships the required sizes quickly from stock – in the grades that contribute to its ease of fabrication *and* performance. For example, Frasse supplies 2024-T4 bars for *strength* and *machinability*, 5052-H34 sheet for *formability* and *weldability* and "775" tooling plate for *dimensional accuracy* with *no distortion when worked.*

Perhaps these same qualities can increase the efficiency of *your* product – or reduce fabricating costs. It's worth investigating – and a Frasse aluminum specialist will be glad to help. There's no obligation – simply write or call your nearest Frasse office. You'll be glad you did.

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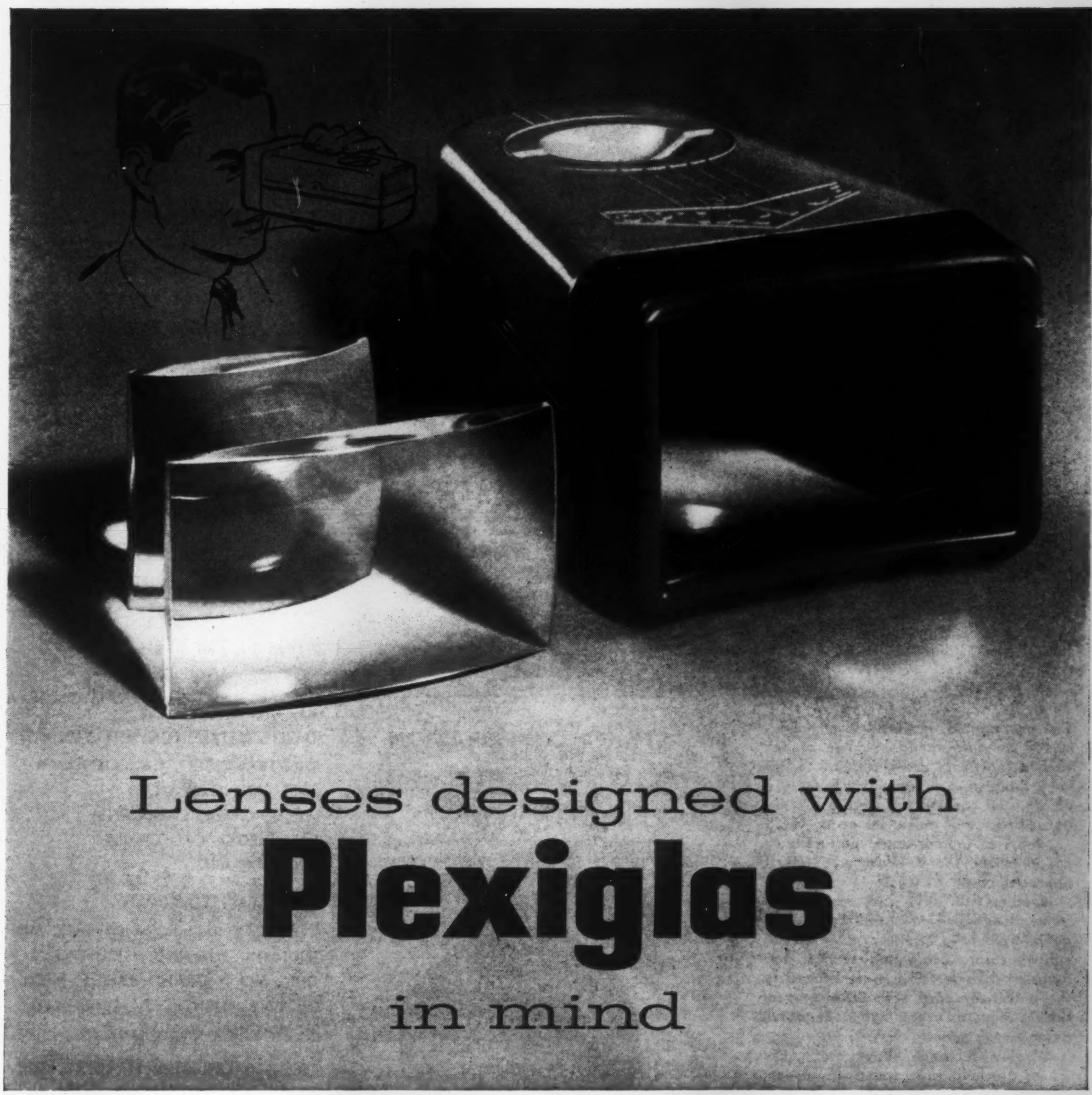

Problem. Design of a magnifying lens system for 35mm slide viewer*.

Requirements. Five-times enlargement of slide picture with clarity, sharpness and freedom from distortion. Lens system to be resistant to impact if viewer is dropped. Viewer to be priced within range of single-lens units.

Solution. Dual lens system, with lenses molded of optical grade PLEXIGLAS® acrylic plastic. Use of PLEXIGLAS resulted in lenses that give excellent performance and are highly resistant to breakage. Because lenses could be *molded* precisely to fine tolerances, considerable production cost savings were achieved through elimination of lengthy grinding and polishing operations required for glass lenses.

"Opta-Vue", by Optics Mfg. Corp., Philadelphia 34, Pa.

Examples of fine quality molded parts made of PLEXIGLAS, *in many fields of use, are shown in our full color brochure, "*PLEXIGLAS *for Molded Parts". We will be pleased to send you a copy.*

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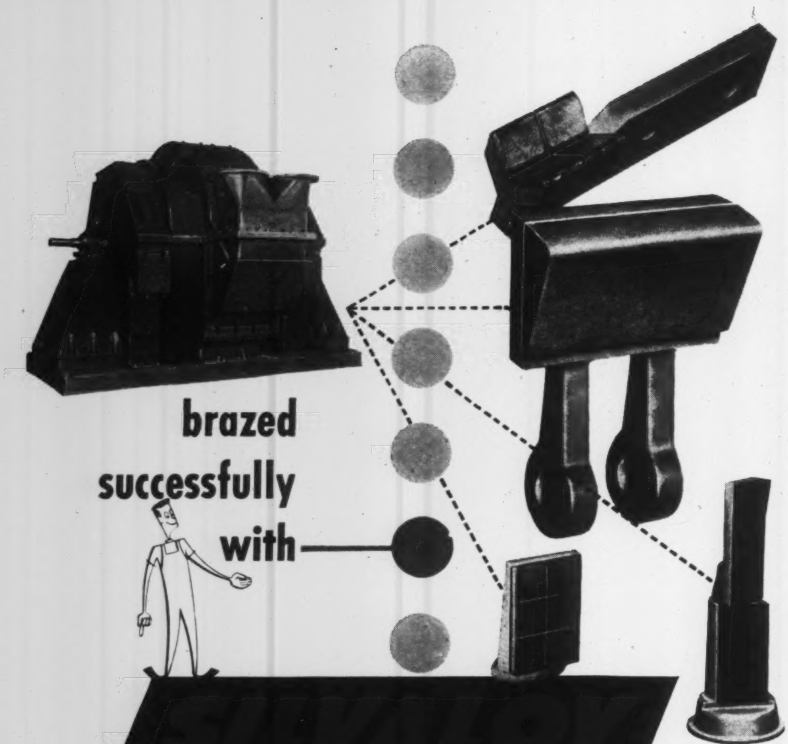

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Needless to say, pulverizers take tremendous punishment, but these are definitely built to "take it." *Riley specifications assure prolonged service.* The tungsten carbide facings are brazed to the pulverizer parts with Silvaloy—producing joints *as strong and dependable as the metals joined.*

Silvaloy Brazing Alloys and APW Fluxes are helping to speed production, lower costs and improve brazing results in many fields. Call your nearest Silvaloy Distributor for information or assistance.

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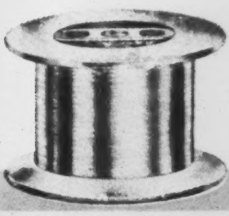
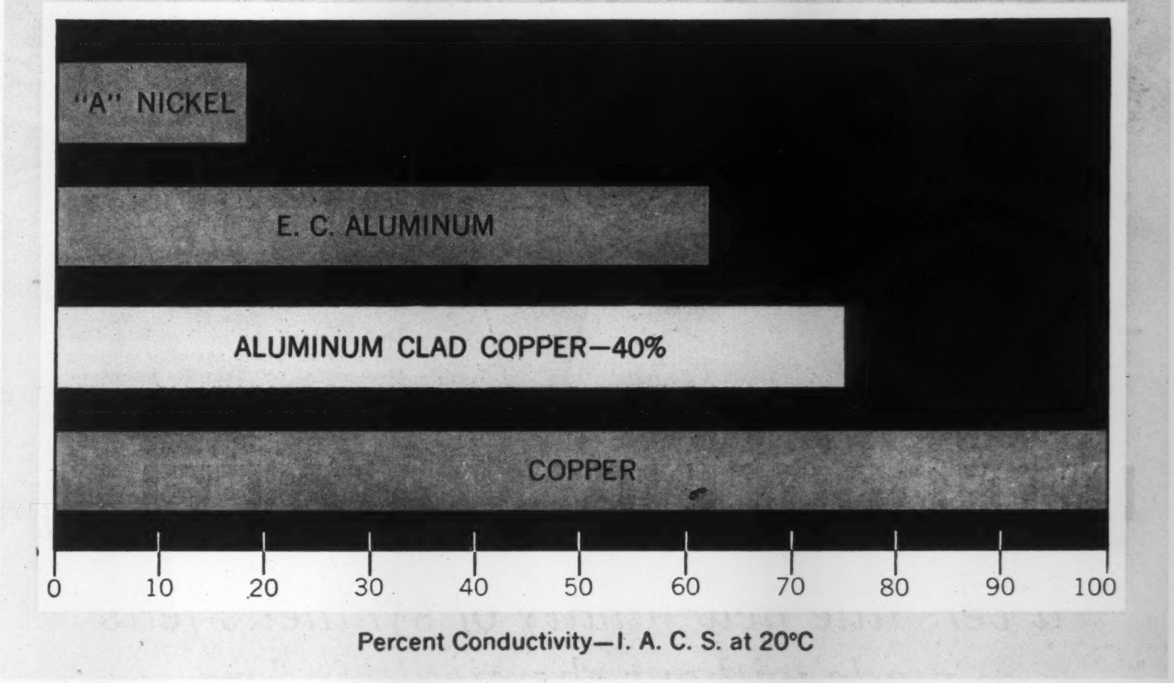
A COMPLETE GUIDE TO SELECTIVE FLUXING FOR LOW TEMPERATURE SILVER BRAZING...
SILVALOY

Two complete reference manuals for low-temperature silver brazing and fluxing are available upon request. Send for either one or both. ★ ★ ★ ★ ★ ★ ★

For more information, turn to Reader Service Card, circle No. 405

New Wire-from Sylvania





Aluminum Clad Copper-40%

Combines the surface, temperature and weight advantages of aluminum with the superior conductivity of pure copper

A new high-conductivity, aluminum clad copper wire designed for the production of high-temperature magnet wire and for high-temperature applications in aircraft, missiles and high-speed industrial equipment has been developed by Sylvania. It can withstand operating temperatures up to 700°F.

The new wire has a conductivity at room temperature approximately 75% of pure copper and considerably higher than pure aluminum. The aluminum cladding measures approximately 40% of the cross-sectional area of the wire.

In addition to its surface, temperature and conductivity advantages, the new aluminum clad copper wire is ready for anodizing to provide a self-insulating surface. Space, weight and cost savings should be of interest to all producers and users of magnet wire.

For further information on new aluminum clad copper, contact your Sylvania Parts Division representative or write to:

Sylvania Electric Products Inc.
Parts Division, Warren, Pa.

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

PARTS
DIVISION

Custom Molded Plastics
Custom Metal Stampings
Custom Welded Parts
Custom Assemblies
Alloy, Clad, Plated Wire
Plated Metal Strip
Electronic Components
Fluorescent Components

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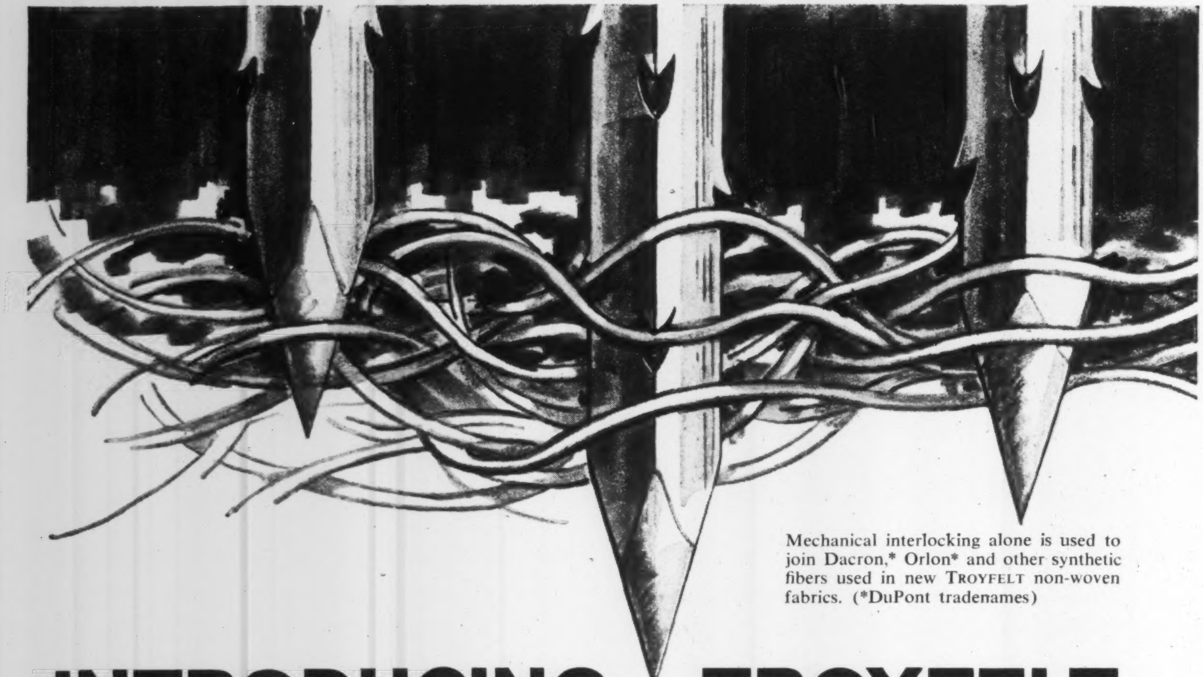

Mechanical interlocking alone is used to join Dacron,* Orlon* and other synthetic fibers used in new TROYFELT non-woven fabrics. (*DuPont tradenames)

INTRODUCING TROYFELT

a versatile new family of synthetic felts made without chemical binders

Where can you use these amazing new felts? Field-tested and proved for more than two years, these are typical reports:

A FILTER MAKER reports TROYFELT outperforming wool felts 7 to 1 in filtering highly abrasive Taconite ore.

AN ELECTRONICS firm finds TROYFELT a superior packing because it stays resilient at high and low temperatures.

A CUTLERY MAKER uses TROYFELT to polish stainless ware . . . finds its smooth surface gives higher luster, lasts longer.

. . . window makers use it as an impervious life-time seal . . . shoe makers because it lasts longer as a padding . . . gasket makers because it die cuts without ravelling . . . it's also used as wadding in cartridges . . . as a vibration isolator.

WHAT IS TROYFELT?

. . . basically, TROYFELT is a non-woven synthetic felt. It is available in Dacron, in Orlon, and in other synthetics. Unlike other nonwovens it has no chemical binders . . . the individual fibers are joined mechanically. Thus it is a softer material, a better insulator, a better filter, a better packing, padding and wick.

And yet TROYFELT *offers all the long-lived properties of the synthetics: a marked resistance to chemical attack, heat, abrasion and wear!*

Want *all* the facts? Just circle the number below on this magazine's handy reply card.

TROYFELT *. . . by the pioneers in non-woven synthetic felts*

INDUSTRIAL PRODUCTS DIVISION • TROY BLANKET MILLS

200 Madison Avenue • New York 16, New York

For more information, turn to Reader Service card, circle No. 443

IN PRODUCT AFTER PRODUCT AFTER PRODUCT

. . . WEIRTON HOT- AND COLD-ROLLED SHEET

In automobiles and portable TV cabinets, in air conditioners, stoves and laundry equipment—in almost any application you can name you'll find Weirton hot- and cold-rolled sheets at work.

Their roles: helping one manufacturer after another to produce standout products at low cost with no hitches in fabrication.

You can put to good use the uniform gauge, strength and ductility of Weirton hot- or cold-rolled sheet.

Weirton is always ready to serve your needs for quality sheets. For prompt and complete service just phone or write Weirton Steel Company, Dept. E-3, Weirton, West Virginia.

WEIRTON STEEL COMPANY

WEIRTON STEEL COMPANY
WEIRTON, WEST VIRGINIA
a division of
NATIONAL STEEL CORPORATION

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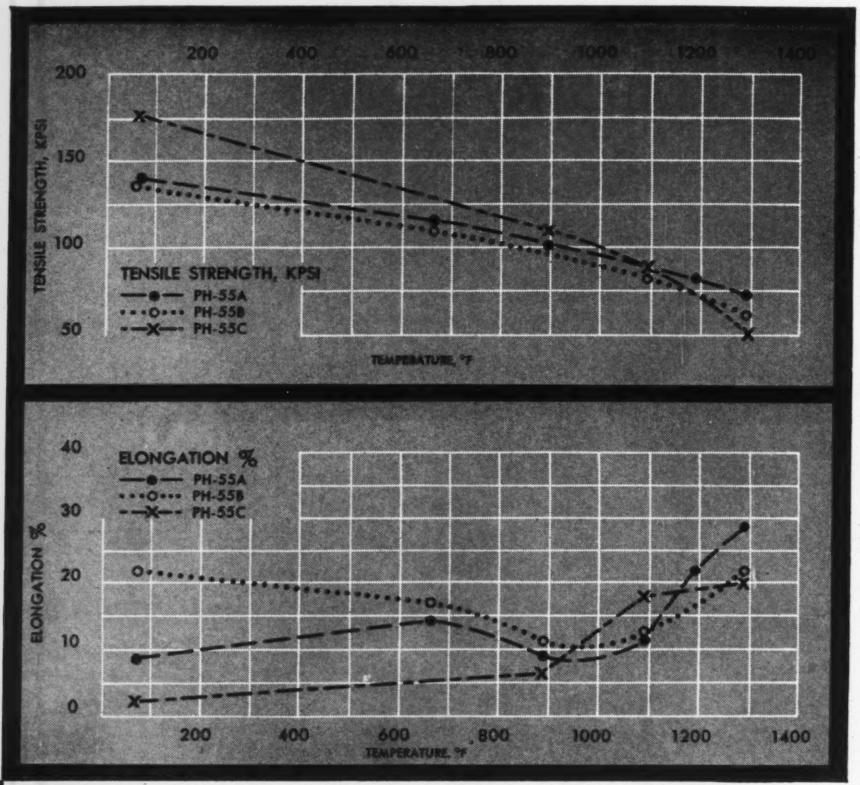


Balanced physical properties—Alloy "A" has good hardness and strength, even at elevated temperatures, plus a moderate amount of ductility and toughness. "B," though less hard, exhibits improved ductility and toughness at practically the same strength level. "C" provides optimum combination of hardness and strength at room temperatures.

Precipitation-hardenable stainless steel alloys by Cooper Alloy that combine corrosion resistance, high hardness, machinability and strength even at high temperatures.

New stainless steel alloys by Cooper Alloy

Where Can You Use Them? Cooper Alloy Corp., whose name for the past 36 years has been associated with outstanding developments in casting of stainless steel, now brings American industry another unusual "first": a series of 18-8 stainless alloys which combine corrosion resistance, high hardness, high strength and machinability. The new alloys maintain these properties even at temperatures up to 1400°F., resisting pitting corrosion and the detrimental erosion effects of velocity and suspended abrasives which accentuate corrosion damage.

The alloys in this new series are:

PH-55A: A high-strength, high-hardness alloy designed for corrosion-erosion and corrosion-abrasion conditions. Outstanding pitting resistance.

PH-55B: A high-strength alloy of greater ductility and lower hardness than "A," for corrosion resistance of parts subjected to a combination of stress and shock.

PH-55C: With greater corrosion resistance, hardness, and strength than "A," but less ductility and shock resistance.

All PH-55 Alloys have higher strengths in the 1200-1400°F. range than do most other corrosion-resistant precipitation-hardening alloys, and they maintain their hardness even after prolonged exposure to these high temperatures. Alloy "A" is highly resistant to pitting corrosion; both "A" and "C" to high-velocity erosion-corrosion such as is common in pumps handling corrosive abrasives. All three are in general superior to 316 alloys in all corrosive applications except hot conc. HNO_3. Patents have been applied for or granted on the PH series of alloys.

Alloys "A," "B," and "C" are all easily machined when in the annealed condition. Welding is routine, and heat treatment easy and relatively uncritical.

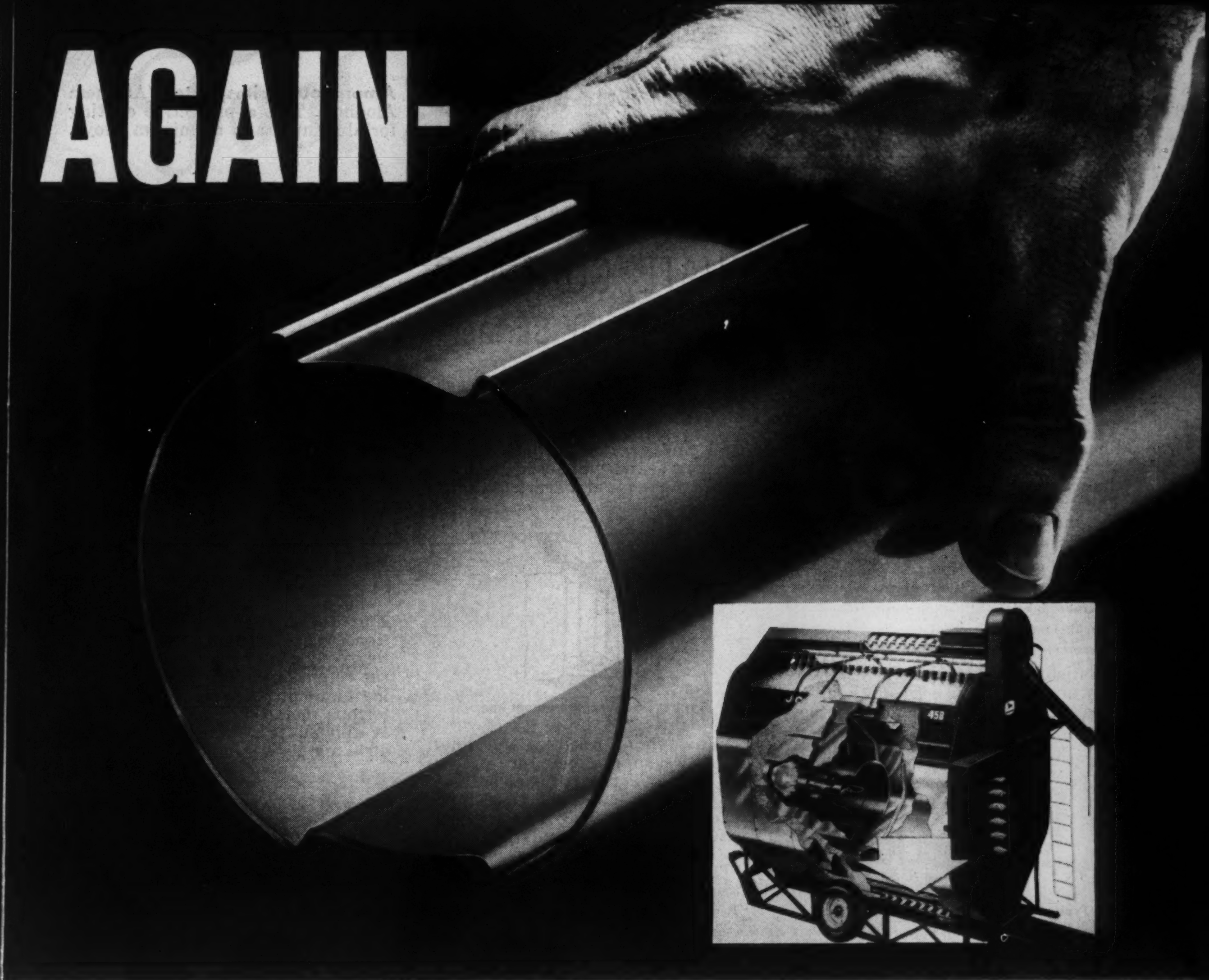
Where can YOU use these alloys? They should be very useful anywhere that velocity, abrasion, wear, and high temperature are present under highly corrosive conditions.

For further information, write to Cooper Alloy Corp., Hillside, N.J.

COOPER ALLOY

For more information, turn to Reader Service card, circle No. 525

For more information, circle No. 413 ➤



Revere helped "fit the metal to the job"

. . . AIDING JOHN DEERE IN DESIGNING ITS FIRST GRAIN DRYER

The greatest bugaboo the farmer has to contend with in harvesting grain is the weather. If it is bad and the grain passes its peak of yield he loses time and money. The new JOHN DEERE 458 Grain Dryer makes it possible for the farmer to harvest when his grain reaches peak yield.

The Dryer was designed from the ground up to be superior in every respect yet competitive in price. In order to assure even feeding of the grain from the start, two metering rolls at the base of the machine are used (Cutaway above shows position of rolls in machine while large illustration is section of the Revere Welded Steel Tubing used for the 44¼" long rolls).

In designing this Dryer JOHN DEERE Engineers considered various kinds of materials, finally specifying Revere Welded Steel Tubing, cold rolled 4½" OD x .065" wall, in the special grooved shape you see above, as being the best material available. Although difficult to fabricate, by most mills, Revere encountered no problems because of its vast experience in producing welded steel tubing in various shapes, sizes and gauges . . . from ¼" to 5" OD round, with walls from .028" to .250" depending on the size.

In fact it was the availability of the tube, plus the experience of making it in large sizes that decided DEERE Engineers to specify Revere. Performance of the tube, JOHN DEERE tells us, has been highly satisfactory.

What are *your* steel tubing needs? More than likely Revere can help you too. It costs nothing to inquire.

REVERE COPPER AND BRASS INCORPORATED
Founded by Paul Revere in 1801
Rome Manufacturing Company Division
Box 111, Rome, N. Y.

AMCHEM Information Bulletin

A REVIEW OF PHOSPHATE COATINGS

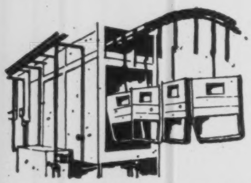
Specified for the Protection of Metal Surfaces

By HUGH GEHMAN, Assistant Manager, Product Development Dept., AMCHEM PRODUCTS, INC.

Phosphate coatings are protective inorganic finishes that actually change the chemical nature of metal surfaces. The metal reacts with the applied phosphate solution to form a nonmetallic, crystalline coating which serves to:

- **Improve paint adhesion**
- **Provide protection against corrosion**
- **Increase lubricity of friction surfaces**
- **Facilitate mechanical deformation of metals**
- **Decorate—in many instances**

Satisfactory protection of steel, zinc and aluminum surfaces against corrosion, paint peeling and blistering, and hard wear requires precision methods of chemical conversion coating.



Typical automotive spray installation.

Types of Conversion Coatings

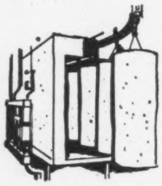
There are seven classes of chemical conversion coatings commonly specified and used throughout industry today. They are as follows:

Zinc-iron phosphate (Amchem Granodine). This is the heaviest type of coating (gray in color) used for prepaint treatments on steel, iron and zinc surfaces. The process requires five or six operations: cleaning; rinsing; rust removal, if necessary; coating; rinsing; and a second rinse. Coating weight ranges from 100 to 600 mg per sq. ft.

Medium or large volume production of automobile bodies, appliances, projectiles and cabinets can be handled effectively.

The coating solution improves paint adhesion by forming a crystalline deposit over the metal surface. This deposit is rough, as revealed microscopically, and so offers an ideal gripping surface for paint particles.

Manganese-iron phosphate (Amchem Thermoil-Granodine). This is a heavy black coating used on friction surfaces to prevent galling, scoring and seizing of parts. Typical metal parts treated are pistons, piston rings, gears, cylinder liners, camshafts, tappets and various small arms components.



Typical appliance treatment line.

Iron phosphate (Amchem Duridine). This is a comparatively new process that places a light coating on surfaces for improved paint adhesion. Since cleaning and coating occur in the same bath, it has only three to five stages.

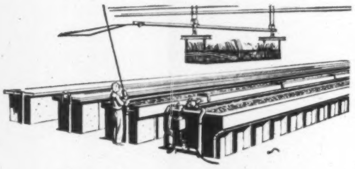
The iron phosphate treatment is a spray process suited for medium to large volume, large or small work. Precleaning is normally unnecessary, an economy factor in its favor.

Products protected by this process are steel or iron fabricated units, such as cabinets, washing machines and refrigerators. Weight of coating is 50 to 100 mg per sq. ft.

Zinc phosphate (Amchem Lithoform). This is a crystalline coating produced on galvanized iron and other zinc surfaces—also cadmium—for improving paint adhesion. The purpose of the coating is to provide a paint-gripping surface and to prevent the reaction between acidic components of the paint and the zinc metal, with the formation of soaps and loss of paint adhesion.

This coating is applied in weights of 75 to 500 mg per sq. ft. There are no limitations on volume or production or on size of products treated. Zinc phosphate coating is used on zinc alloy die castings, zinc or cadmium plated sheet or components, hot dip galvanized stock, and Galvanneal.

Amorphous phosphate (Amchem Alodine). This a protective coating for aluminum and aluminum alloys.

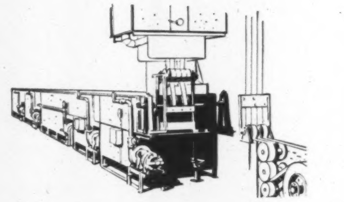


Typical aircraft dip installation.

It may be used in place of anodic deposition for improved paint adhesion and corrosion resistance.

This coating is practical for production in any volume. Coating weight is 100 to 600 mg per sq. ft. Products treated include aluminum awnings, doors and windows, aircraft and aircraft parts, missile parts, roofing and siding. Particularly good when aluminum is painted prior to forming.

Zinc-iron phosphate for oil absorption (Amchem Permadine). This is a relatively heavy coating adapted to the retention of rust-inhibiting drying or nondrying oils and waxes on ferrous metal surfaces. The coating is applied to a weight of 1000 to 4000 mg per sq. ft.



Typical continuous strip line installation.

The process is satisfactory for large or small work in any volume—nuts, bolts, hardware, guns, tools, etc.

Zinc-iron phosphate for metal forming (Amchem Granodraw). This is a specialized coating used in conjunction with a suitable lubricant to facilitate the cold mechanical deformation of steel. The coating acts as an anchor for the lubricant throughout drawing, extrusion, and cold forming operations.

It is a successful treatment for products such as blanks and shells for cold forming, heavy stampings, impact extruded shapes, drawn wire and tube.

For more complete information about any one or all of these chemical conversion coatings, contact an Amchem sales representative or write us at Ambler 00, Pa.

AMCHEM PRODUCTS, INC. (Formerly American Chemical Paint Co.)

AMBLER 17, PA. • Detroit, Mich., St. Joseph, Mo., Niles, Calif., Windsor, Ont.

Amchem, Granodine, Thermoil-Granodine, Duridine, Lithoform, Alodine, Permadine and Granodraw are registered trademarks of Amchem Products, Inc.

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Tool Steel Topics

BETHLEHEM STEEL

the Pacific Coast Bethlehem products are sold
Bethlehem Pacific Coast Steel Corporation

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributors
Bethlehem Steel Export Corporation

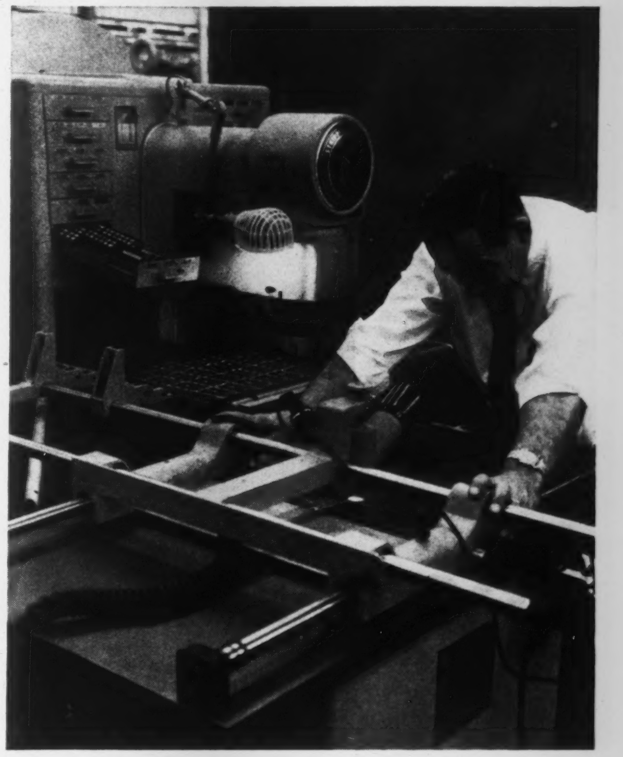
It's so easy to punch hole patterns fast with BTR

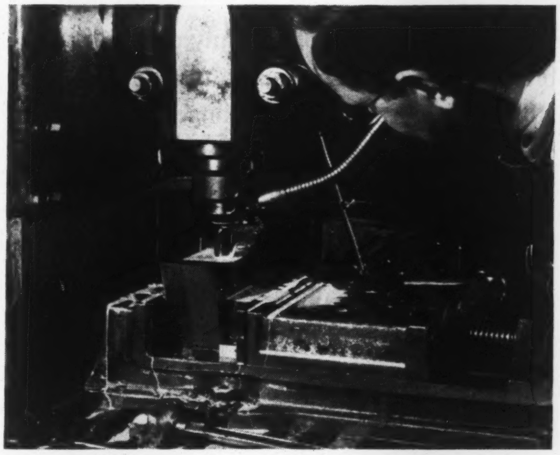
A punch made from BTR tool steel is the key element in this punching mechanism. It speeds the accurate reproduction of hole patterns, by remote control from a template, in sheets of steel, brass, aluminum, or plastic.

The BTR punch has proved both reliable and economical. This is the report from Wales-Strippit Inc., Akron, N. Y., a unit of Houdaille Industries, producers of the equipment. The Bethlehem tool steel is supplied by Leed Steel Co., Buffalo, one of our local tool steel distributors.

BTR is Bethlehem's general-purpose manganese-chromium-tungsten grade of oil-hardening tool steel. It's safe hardening, easy to machine. Combining abrasion-resistance and toughness, it's ideal for a wide range of tool and die uses.

Put BTR to work in your shop. A trial order can be delivered quickly by your Bethlehem tool steel distributor who carries BTR in stock in a wide size range.





New Free-Machining Tool Steel

Bethlehem Air-4 is an air-hardening tool steel which can save you time and money in scores of applications. It is a free-machining grade, and hardens at about 1550F. It combines excellent wear-resistance with a high degree of toughness. Ask your distributor for full data on Bethlehem Air-4.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

Decarburized surfaces are the cause of premature tool failures

The great majority of toolmakers know that decarburized metal must be removed completely from the working surfaces of tools. It is not so widely known that it is often best to remove this skin from other portions of the tool.

This precaution is especially necessary on tools which are subject to repeated impacts. For example, a pneumatic chisel which has a forged shank often breaks because of a fatigue failure. As a rule there is a stress concentration in the shank, due to the change in section. When this tool surface is also decarburized, rapid failure in service can occur.

The outer layers of a decarburized tool haven't the strength of the effectively hardened tool steel base. Therefore only one procedure can be considered safe. It is to grind off the "decarb" on *all* tool surfaces.

For more information, turn to Reader Service card, circle No. 475

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REPLACE IT WITH CARBON OR GRAPHITE AT LESS OVERALL COST!

"NATIONAL" CARBON AND GRAPHITE ARE WORKING WONDERS IN . . .

MECHANICAL, METALLURGICAL, ELECTRICAL and NUCLEAR APPLICATIONS

Rare metals and ceramics are not the only materials that master problems of heat, corrosion and conductivity. Graphite withstands thermal impact longer than many costlier refractories. Its easy machinability cuts fabricating costs. Its corrosion resistance simplifies chemical processing. Its heat-transfer power speeds casting. Its structural qualities and low neutron capture make it ideal nuclear material. Learn more about graphite and its parent-substance, carbon. Fill in the coupon below.

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"SILICOL"® SILICONE RUBBER

can improve your product and simplify fabrication problems

★ ***ANY MOLDED SHAPE***

★ ***ANY COMPOUND FORMULATION***

Colonial Rubber has a long record of achievement in using the unique properties of silicone rubber to meet "tough service" applications in all types of manufacturing. Particularly outstanding are the many special compounds our chemists have formulated to meet unusually rigid performance requirements in aircraft and missile applications.

In addition to the comprehensive industrial rubber technology we offer to help manufacturers solve rubber compounding problems. Colonial has large, modern and complete plant facilities to assure lower cost rubber molding and fabricating. We are *known* for our ability to meet manufacturer's "emergency" delivery requirements on priority projects.

Save time on your programs by sending prints and pertinent data on your *first* inquiry. We will promptly return an analysis and recommendations, together with illustrated information giving you complete details on our organization and its ability to serve you efficiently and economically.

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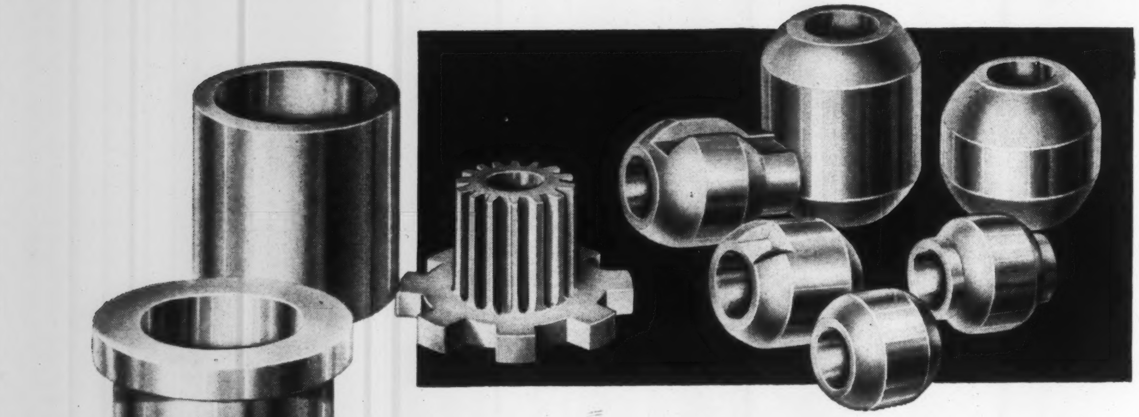

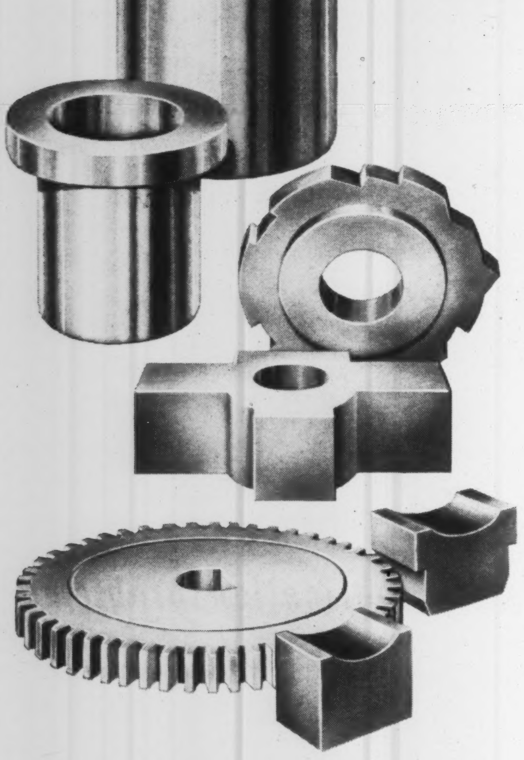

Johnson
Ledaloyl Powder Metallurgy

Bronze or Iron
Bearings . . . Bushings . . . Parts
Offer Many Important Savings

Pre-Lubrication—The porous structure of Johnson Ledaloyl acts as a reservoir for the lubricant, providing sufficient oil during operation . . . storing it when at rest. This feature often eliminates costly lubricating devices and systems, guards against neglect and assures longer operating life of the unit.

Formed to size—The manufacturing process of Johnson Ledaloyl is essentially a forming and sintering operation. This eliminates machining, prevents scrap, yet provides accuracy at a low unit cost. Uniformity of each bearing, or part, cuts assembly time to a minimum. These are but two of the many money-saving features of Johnson Ledaloyl bearings, bushings, and structural parts. Let us show you how to design your product to take full advantage of this economy yet gain greater performance and longer service life. No obligation of course. Write for literature today.

This literature free upon request.

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Ledaloyl Bearings

Johnson Bronze

769 South Mill Street • New Castle, Pa.

Subsidiary: Apex Bronze Foundry Co., Oakland, California

JOHNSON Bearings

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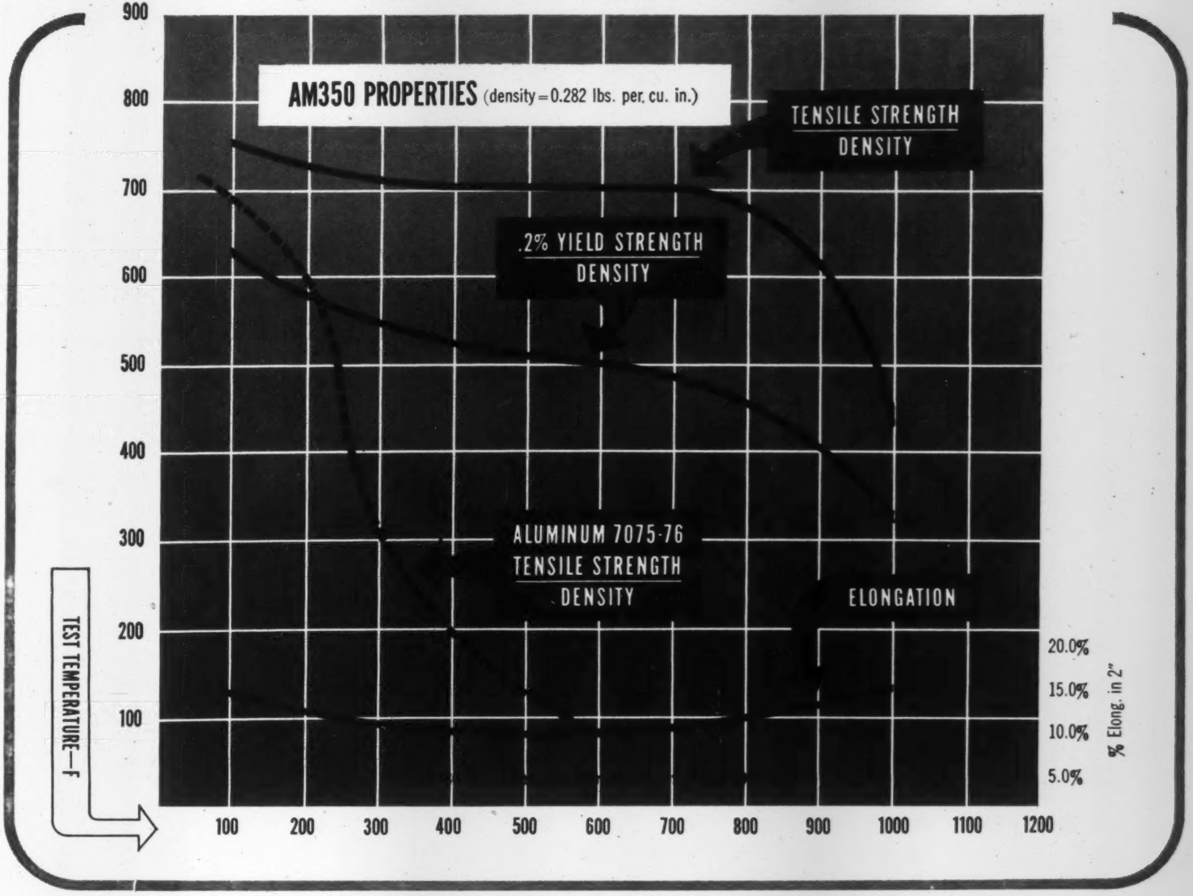
Experience** — the added alloy in **Allegheny Stainless



Two for the space age—AL's AM-350 and AM-355 precipitation hardening steels

A unique combination of highly desirable properties describes Allegheny Stainless AM-350 and AM-355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many space age problems. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM-350 and AM-355.

AVAILABILITY: AM-350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM-355, best suited for heavier sections, is available commercially in forgings, forging billets, plates, bars and wire.

CORROSION RESISTANCE: Compared to the more familiar stainless grades, AM-350 and AM-355 resist corrosion and oxidation better than the hardenable grades (chromium martensitic) and only slightly less than the 18 and 8's. They resist stress corrosion at much higher strength levels than do martensitic stainless grades.

SIMPLE HEAT TREATMENT: High strength is developed by two methods. Both minimize oxidation and distortion problems. The usual is the Allegheny Ludlum-developed sub-zero cooling and tempering (SCT): minus 100F for 3 hrs plus 3 hrs at 850F. Alternate method is Double Aged (DA): 2 hrs at 1375F plus 2 hrs at 850F.

EASY FABRICATION: AM-350 and AM-355 can be spun, drawn, formed, machined and welded using normal stainless procedures. In the hardened conditions, some forming may be done . . . 180 degree bend over a 3T radius pin. Also AM-350 can be dimpled in the SCT condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM-350 and AM-355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa. Address Dept.* MM-17

WSW 7516

ALLEGHENY LUDLUM

Export distribution: AIRCO INTERNATIONAL

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

AL

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Engineers: Here are sound reasons why it pays to specify USS Shelby Seamless Mechanical Tubing

USS Shelby Seamless Steel Mechanical Tubing offers you extraordinary freedom of design in a wide range of products from bushings to hydraulically operated telescoping booms. And, Shelby Seamless Tubing helps cut processing costs, because it eliminates drilling operations; enables you to replace drills with simple, less expensive boring tools, and it reduces tool wear and tool changes; and, more important, more uniform parts can be turned out by the hundreds or thousands.

Where Shelby Seamless Tubing is used as a load-carrying member or part, it exhibits a number of structural advantages over other forms. *Here are a few:* it gives you a superior cross section when a part is designed to withstand equal loading in any direction; it resists bending stresses equally in all directions; it is able to absorb and localize shock; and in torsion, it provides better material distribution, and for a given weight, can withstand more load than other sections.

And, of course, the name Shelby is backed by the world's largest and most experienced manufacturer of seamless tubing—National Tube! The production of Shelby Seamless Tubing, from ore to finished product, is entirely controlled by one organization. There is no divided responsibility. Every foot, every length, is made under the careful supervision of skilled men with years of tubemaking experience. For more than 60 years, Shelby Seamless Tubing has been first with men who want the best in mechanical tubing.

You'll find Shelby Seamless Tubing available at select Shelby Distributors throughout the country. These distributors are strategically located and expertly trained in solving all types of tubing problems. Here, you can choose from a complete range of sizes and stocks. If you'd like to find out how Shelby Seamless Tubing can be most effectively applied to your designs, contact your nearest Shelby Distributor . . . *soon!*

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USS **National Tube**
Division of
United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division · United States Steel Export Company, New York

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QUALITY CAN PUT YOU AHEAD OF COMPETITION

Many a Scovill customer has said to us, in effect, "We're doing so well with Scovill Mill Products that it's giving us a nice little 'edge' on the competition. Don't tell our competitors". But that kind of "secret" cannot be kept for long, and it's a fact that more and more fabricators are following up the smart lead and switching to a higher standard of quality in Scovill Brass • Copper • Aluminum. They're finding that Scovill's deliberately planned program of constant improvement in mill production equipment and methods pays off in results on the fabricator's own production line.

You can buy Brass • Copper • Aluminum Mill products from many sources . . . BUT Scovill fabricator-oriented services are available only from . . . the source of Mill Products bearing this Trademark.

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Scovill Manufacturing Company, Mill Products Division, 99 Mill St., Waterbury 20, Conn. Phone Plaza 4-1171.

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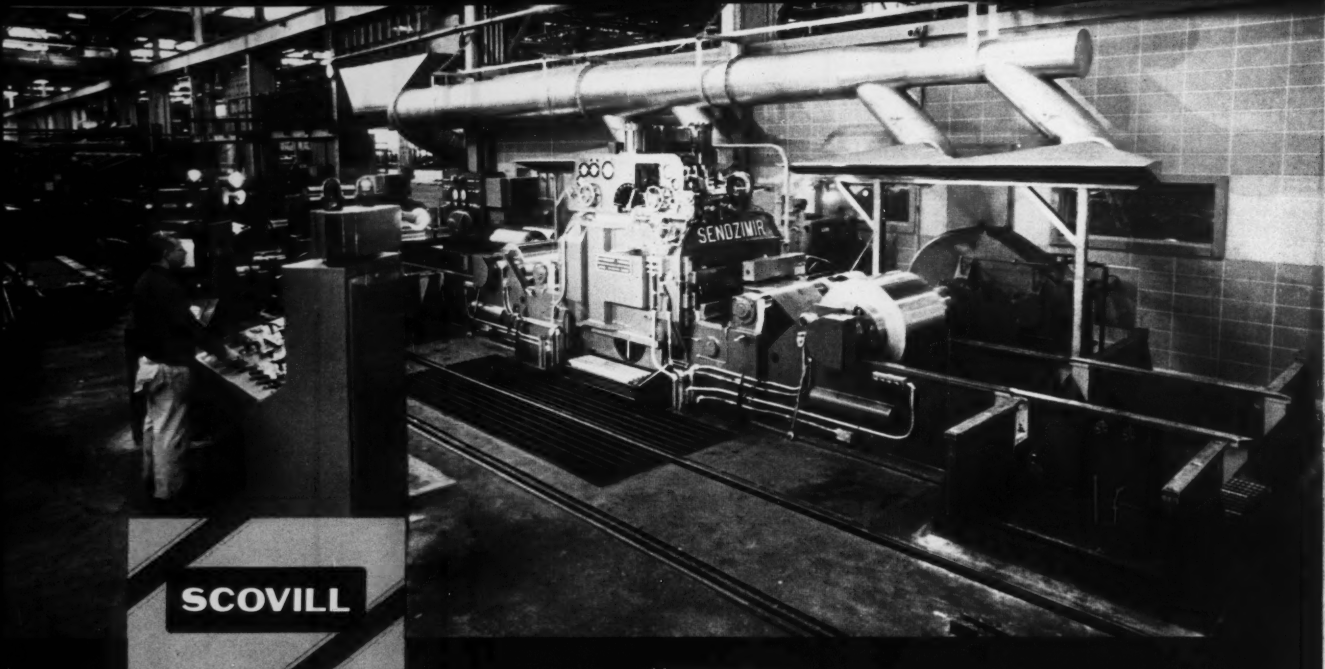

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Here is the last word in rolling mill equipment and coordinated precision controls for production of brass strip and aluminum sheet to far closer dimensional tolerances and with far superior micro-inch finish than that available under previous commercial standards.

Fabricators who have been awaiting materials of such "super" accuracy, uniformity and micro-inch surface finish can expect these important benefits:—

- A dependably close ratio between anticipated footage of metal, weight of metal and actual parts produced, because of precision controlled gauge tolerances.
- Fewer press or other machine adjustments and longer tool wear with the use of metal that is more uniform in all respects.
- Superior finish and appearance of parts as a result of much closer micro-inch finish control.

Fabricators requiring this extra measure of quality, this extra aid to maximum economy in production of brass or aluminum parts, are invited to discuss this new Scovill Service.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

made better to bring out the BEST in your products

it PAYS to specify...

BRASS

COPPER

ALUMINUM

MILL PRODUCTS

identified by this trademark

SCOVILL ®

Scovill Manufacturing Company, Mill Products Division, 99 Mill St., Waterbury 20, Conn. Phone PLaza 4-1171.

99C39

KNOW YOUR ALLOY STEELS . . .

This is the first of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

What is an Alloy Steel?

Here is an easy definition to remember: An alloy steel is a grade of steel in which one or more alloying elements have been blended to give it special properties that cannot be obtained in carbon steel.

Or, here is the metallurgical definition: An alloy steel is one in which the maximum specified content of alloying elements exceeds one or more of the following limits—

Manganese, 1.65 pct; Silicon, 0.60 pct; Copper 0.60 pct

or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized commercial field of alloy steels: aluminum, boron, chromium up to 3.99 pct, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other element added to obtain a desired alloying effect.

As a rule, alloy steel is more difficult to make than carbon steel. There are more elements to be kept within specified ranges and, in general, the ranges of the alloying elements are comparatively narrow; hence the mathematical chances for producing off-heats are correspondingly increased. Moreover, most alloy steels require special reheating and cooling to prevent such imperfections as flaking and cracking.

Surface imperfections must be removed from the billets by scarfing, chipping, or grinding. More exacting methods of testing and inspection are necessary to insure uniformity.

Where Does It Pay To Use Alloy Steel?

Generally speaking, it is advisable to use alloy steel when more strength, ductility, and toughness are required than can be obtained in carbon steel in the section under consideration. Alloy grades should also be used where specific properties such as corrosion-resistance, heat-resistance, and special low-temperature impact values are needed.

In some cases it requires considerable study to determine when and how to use a particular alloy steel to advantage in a product. Where there is any problem or doubt concerning its use, Bethlehem metallurgists will gladly give impartial advice on analysis, heat-treatment, machinability, and expected results.

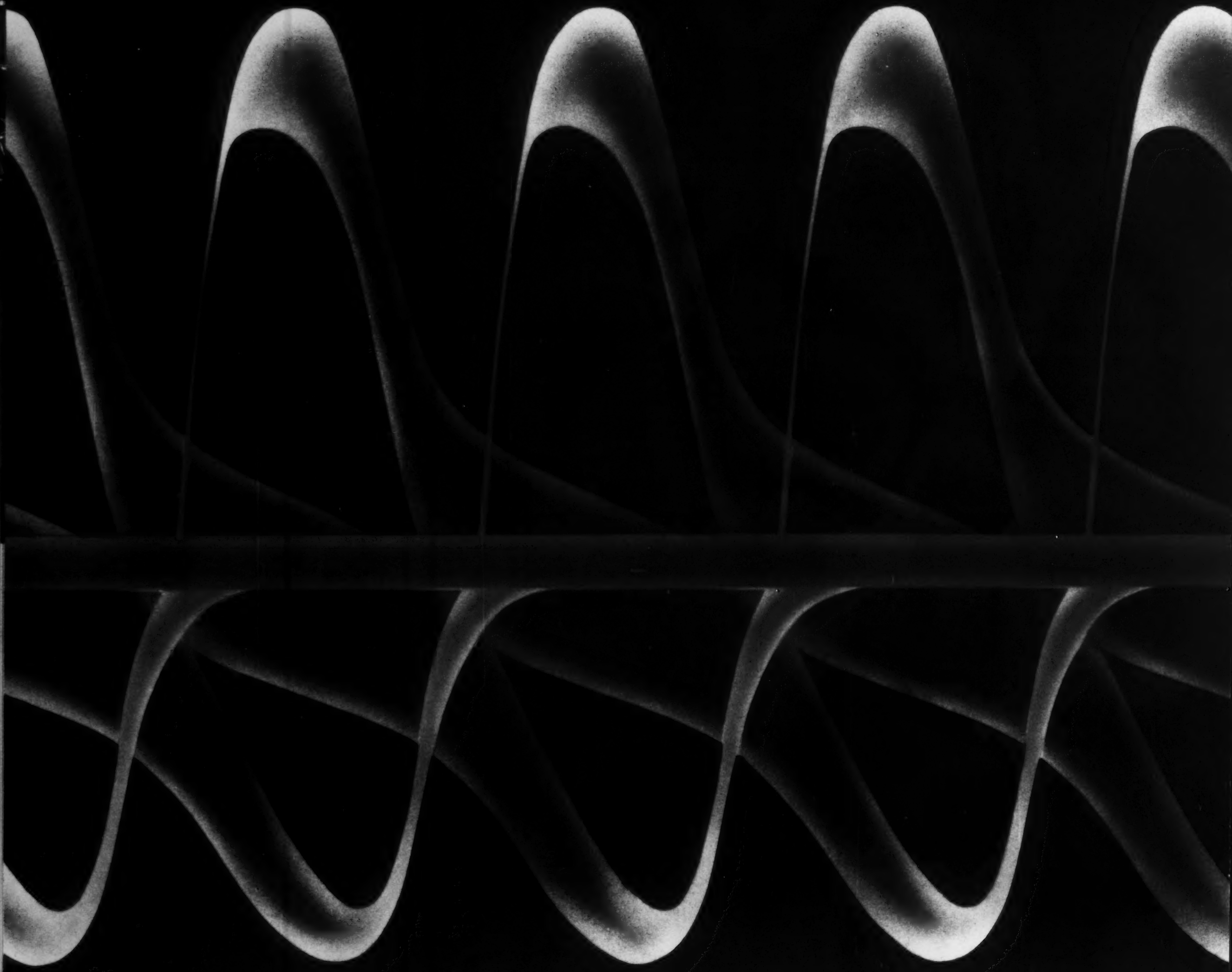
In addition to manufacturing all AISI standard alloy steels, this company produces other than standard analysis steels and the full range of carbon grades.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 508



The cathode ray oscilloscope is one of science's and industry's most perceptive instruments for determining uniformity of operation. The pattern reproduced here is a harmonically modulated sine wave of exact uniformity.

Uniformity is Malleable

Just as the input of an oscilloscope can be controlled to produce repetitive patterns, so can consistently uniform metal parts be produced with Malleable iron because of modern, scientific controls. The unique method by which all Malleable castings are made and the exacting techniques employed by Malleable foundries assure Malleable users of castings that are uniform, part after part, regardless of size or shape. This uniformity, combined with unparalleled physical and mechanical properties, ideally suits Malleable castings for modern America's quality products.

For information or service, call on one of the progressive firms that identify themselves with this symbol—

MEMBER
MALLEABLE
CASTINGS COUNCIL

If you wish, you may inquire direct to the Malleable Castings Council,
Union Commerce Building, Cleveland 14, Ohio, for information.

(Advertisement)

Better Products at Lower Cost Result From Malleable Uniformity Controls

Uniform quality — whether for five or five million pieces — is essential to maintain product quality and increase manufacturing efficiency. With accelerating frequency, Malleable castings contribute their unique uniformity in critical applications where durable, reliable components are necessary.

Key to Uniformity is Control

Malleable iron is produced under closely controlled manufacturing techniques. From charge composition and molding sand properties, through final inspection, every critical factor is held constant by using the most modern techniques of metal analysis, process control and inspection.

Internal Uniformity

This versatile engineering material is achieved through converting the base white iron into tough Malleable iron by a controlled heat treating process. Malleable's internal structure exhibits excellent uniformity, an important factor in assuring the dependable performance of intricately designed components.

External Uniformity

Fundamental to the casting process is the ability to produce a given shape, time after time, in either small or large quantities. Metal can be placed exactly where it is needed . . . eliminated where it is not. Good design — achieved through close cooperation between the customer and the foundry — can assure the necessary tolerances and the lowest possible finished part cost. Modern techniques of production and inspection are used to insure top quality, dimensionally accurate castings.

The life of every motorist rides in complete safety on Malleable wheel hubs of unerring uniformity

Uniformity Proven by Use

The final test of any part is how well it stands up in actual service. Under continuous cyclic and shock loading, the millions of Malleable wheel hubs, which are in service on the front end of every American-made car, have compiled an enviable record of proven uniformity. Another dramatic example of Malleable's uniformity is proved in the old adage "A chain is only as strong as its weakest link." Miles of Malleable chain, carrying tremendous loads year after year without failure, demonstrate the uniformity of every cast link.

New techniques for controlling every element of Malleable production are the result of intensive research done by Malleable foundries in their continuing search for ways to make Malleable even more versatile and indispensable to industry.

More Information Available

Your copy of *Data Unit 103—Uniformity* — is available from any member of the Malleable Castings Council. If you prefer, write direct to Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

These companies are members of the

MALLEABLE CASTINGS COUNCIL

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Link-Belt Company, Indianapolis 6
Muncie Malleable Foundry Co., Muncie
Terre Haute Mall. & Mfg. Corp., Terre Haute

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
Cadillac Malleable Iron Co., Cadillac
Central Fdry. Div., Gen. Motors, Saginaw

MINNESOTA
Northern Malleable Iron Co., St. Paul 6

NEW HAMPSHIRE
Laconia Malleable Iron Co., Laconia

NEW JERSEY
Meeker Foundry Company, Newark 4

NEW YORK
Acme Steel & Mall. Iron Works, Buffalo 7
Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Canton Malleable Iron Co., Canton 5
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

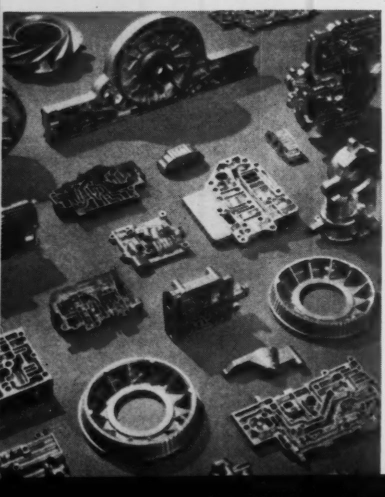
WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company, West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

For more information, turn to Reader Service card, circle No. 419

Dimensional Control Department at D-J. At D-J dimensional control of die cast parts is so much a part of production routine that a special department is devoted to this purpose. In rooms like this, at every D-J plant, experts verify the dimensions on die castings pulled periodically from the production line.

Outboard motor housing
Instrument panel bezel
Single cylinder engine block
Pinspotter part

At Doehler-Jarvis . . . everything improved production methods



Automatic transmission parts illustrate how much can be done with die cast design. Notice the ganged fluid passageways. Not apparent, but incorporated into the design of each of these parts, are many features that make these parts usable much as they are . . . with a minimum of further manufacturing needed.

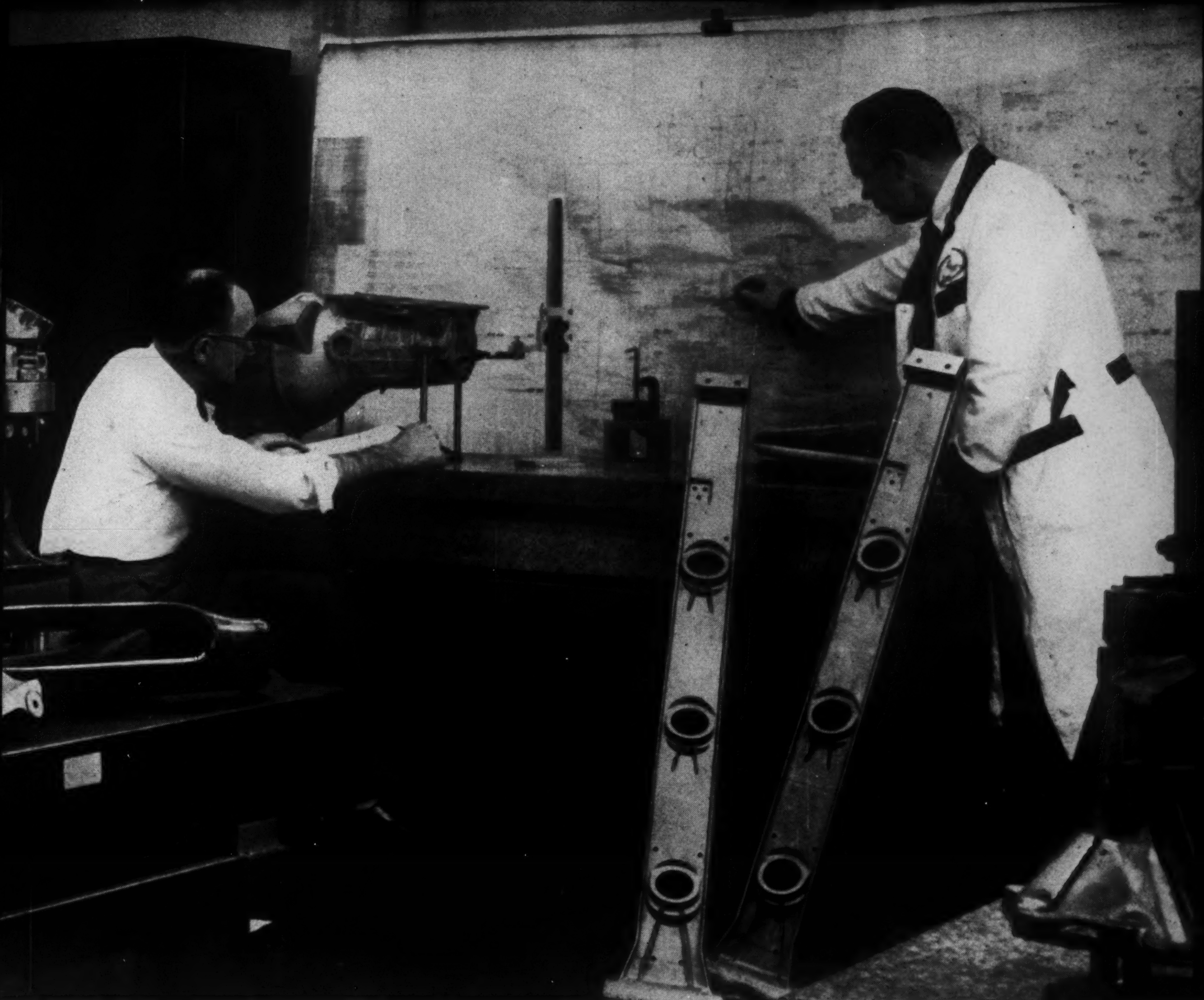
Only a handful of companies have ever taken *full* manufacturing advantage of the inherent opportunities presented by the purchase of die castings — opportunities to so design parts that production *all along the line* is simplified, speeded up, and made more economical.

Frequently die castings are bought under conditions where price is the dominant competitive factor. This approach sometimes makes good purchasing sense. And on the basis of price competition Doehler-Jarvis produces and sells more die castings per year than any other custom die caster.

But there is another, and often more rewarding, way to look at the purchase of die cast parts.

In many instances — most, in fact — a careful analysis of the part by experienced metal production men working in close coordination with equally experienced designers of the dies and the castings reveals ways to:

(1) reduce cost or improve performance of the casting itself.



Transmission housing Pinspotter arms Transmission pa

needed to help you develop with the help of die castings

(2) introduce design features that eliminate one, many, or all of the machining, finishing or sub-assembling operations that must be accomplished before the part can be incorporated into the end product.

For example. Product engineers have only begun to realize the full range of applications made possible by the high fatigue strength inherent in aluminum die castings . . . by integrating several separate parts into one die casting . . . by ganging fluid passageways (as in automatic transmission designs).

Doehler-Jarvis customers who have taken this suggested broad viewpoint in purchasing their die castings find it pays off... sometimes enormously.

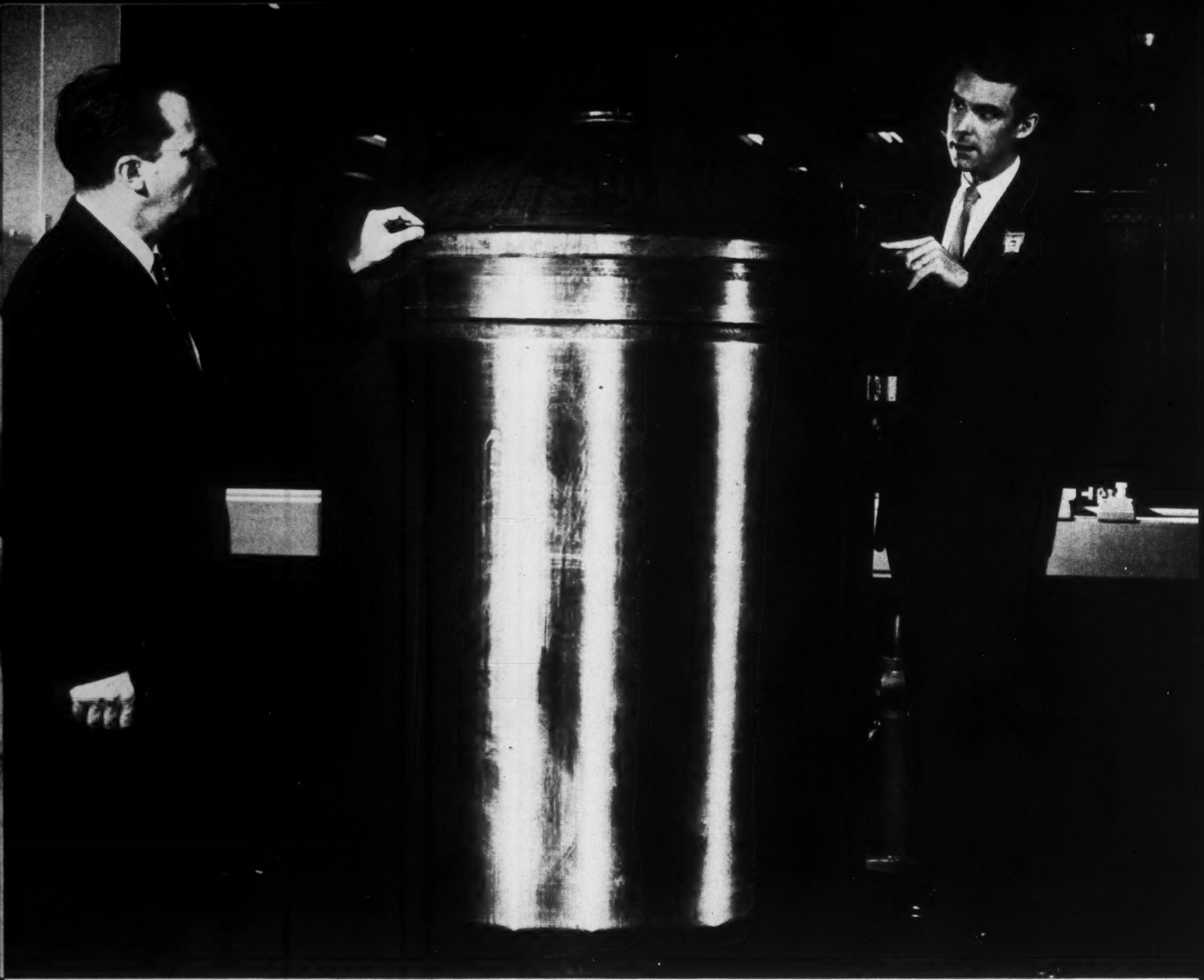
No producer of die castings can contribute more to this broad purchasing concept than Doehler-Jarvis.

In any category you care to name . . . research support . . . design help . . . skilled workmanship . . . versatility of metal working equipment (you can even buy *forgings, extrusions and stampings* from D-J) . . . sub-assembly facilities . . . choice of die casting metals and alloys . . . location of plants . . . delivery . . . Doehler-Jarvis provides more facilities than any other producer of die castings.

See what Doehler-Jarvis can do to help you realize the full potentials in die cast parts production. Call us in at an early stage in the design of your next new product or model change.

Doehler-Jarvis
Division of
NATIONAL LEAD COMPANY
General Offices: Toledo 1, Ohio
In Canada:
Barber Die Casting Co., Limited
Hamilton, Ontario

For more information, turn to Reader Service card, circle No. 538



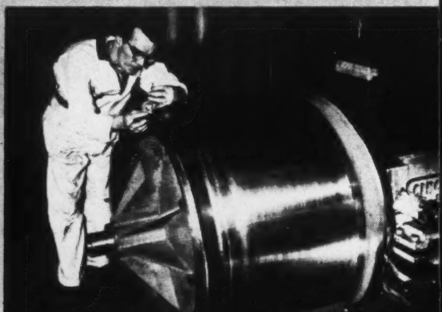
ENGINEERING

IBM 704 COMPUTER permits General Electric engineers to analyze case stresses mathematically, correct design faults before fabrication begins. Computer is one example of advanced engineering capability which provides better case design, 230,000 psi strengths.

METALLURGY

G-E ARC-SPRAYED TUNGSTEN nozzle liners (melting point: 6170°F) are now being incorporated into lightweight, advanced nozzle designs. Early hot tests indicate that extremely high nozzle performance can be attained, a potential provided by G-E advanced metallurgy.

MANUFACTURING



INTEGRAL SKIRTS AND DOMES are roll-formed in General Electric solid propellant cases. Case halves are joined by a single girth weld as strong as the case itself. General Electric is applying more than six years of roll-forming experience to case manufacture.

ROCKET ENGINES

New solid propellant cases with . . .

230,000 psi YIELD STRENGTH

Solid propellant rocket motor cases with yield strengths in the range of 230,000 psi are now under development at General Electric in conjunction with the Thiokol Chemical Corporation. These full-size cases are among the strongest and most advanced in the U.S. missile industry. They will be used to contain and direct the powerful forces generated in the powerplants of highly advanced solid propellant missiles.

Now underway at General Electric are equally advanced developments relating to high temperature tungsten throat liners for lightweight nozzle applications. Liners such as these are now being incorporated into advanced nozzle designs being developed by Thiokol Chemical Corporation.

General Electric's advanced rocket engine capabilities embrace engineering, metallurgy, manufacturing, research and development. They can meet your needs for high performance solid propellant motor cases and nozzle materials, or for liquid engine components.

Progress Is Our Most Important Product

GENERAL ELECTRIC

For more information, circle No. 539

RESEARCH AND DEVELOPMENT

GENERAL ELECTRIC IS PIONEERING "aus-forming". Demonstration cases exhibit 340,000 psi yield strengths with elongations improved 10–12%. In nozzles, hafnium and tantalum carbide (melting point: 8700°F) combinations are being investigated.

The Flight Propulsion Laboratory Department's Rocket Engine Section is the nucleus of General Electric progress in rocket engines and their components. It is well-equipped; and it uses Company-wide capabilities and experience to speed advances. If you would like more information about the Section's products and capabilities in solid or liquid propulsion systems, please mail this coupon. *Rocket Engine Section, General Electric Co., Cincinnati 15, Ohio.*

182-1

Rocket Engine Section
Flight Propulsion Laboratory Department
General Electric Company
Cincinnati 15, Ohio

Please send me additional information about General Electric solid propellant cases and nozzles. ☐

Please send me information about liquid propulsion system components. ☐

I would like to discuss G-E rocket engine products with a sales representative. ☐

NAME____________________

TITLE____________________

COMPANY____________________

ADDRESS____________________

CITY____________ **STATE**________

REPUBLIC ELECTRUNITE

world's widest range of

SPECIALTY WELDED TUBING

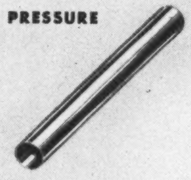
STAINLESS and CARBON

STAINLESS

PRESSURE

HEAT EXCHANGER, CONDENSER AND EVAPORATOR — Full Range of Sizes and Analyses

PRESSURE



PIPING — Complete Range of Sizes in Schedules 40S, 10S and 5S

PRESSURE

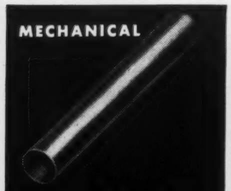
AIRCRAFT—Exhaust Stacks, Hydraulic Lines and Duct Tubing

PRESSURE

SPECIAL BRIGHT ANNEALED — Up to 4" O.D. — Special Shiny Surface

CARBON

MECHANICAL



HOT ROLLED — 1/4" O.D. thru 6" O.D. — 16 Gage thru .250"

MECHANICAL

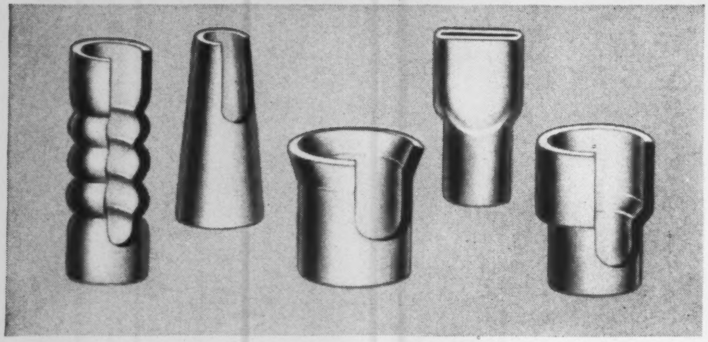
COLD ROLLED — 3/8" O.D. thru 6" O.D. — 22 Gage to 10 Gage

AIR HEATER

AIR PRE-HEATER — Full Range of Sizes

MECHANICAL

SPECIAL SMOOTH I.D. HYDRAULIC CYLINDER — Up to 4½" I.D. and in Wall Thicknesses up to .187"



REPUBLIC ELECTRUNITE MECHANICAL TUBING is easily fabricated and formed by the user or through the fabricating and finishing facilities of Republic's Steel and Tubes Division. Round tubing can be furnished flanged, swaged, flattened, fluted, spun, configured, upset, rolled, and otherwise changed in cross-section to meet an endless variety of design requirements. Write for illustrated brochure.

Republic ELECTRUNITE® offers you the world's widest range of stainless and carbon tubing. Carbon steel round tubing in sizes up to 6" O. D.—squares and rectangles in peripheries up to 20". Stainless steel tubing in sizes up to 5" O. D.—squares and rectangles in peripheries up to 16". And a complete range of stainless pipe sizes.

ELECTRUNITE is quality controlled from ore to finished product. Produced in Republic's own mills to rigid requirements.

Welded by the exclusive ELECTRUNITE process—a continuous electric-weld method that unites the wall under pressure without the addition of foreign or extra metal. Tests prove the weld is as strong or stronger than the original base metal.

Next time you need tubing, whatever the application or problem, call your Republic representative. Or, write direct.

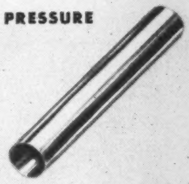
STEEL TUBING AND PIPE

1/32″ O.D. TO 40″ O.D.

PRESSURE

SANITARY — O.D. and I.D. Polished — For Dairy, Food and Fruit Juice Processing

PRESSURE

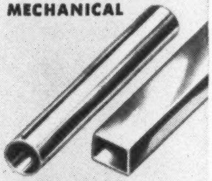


HEAT RESISTANT — Special Analyses — 309, 309S, 310, 321, 330, 347 and 348

PRESSURE

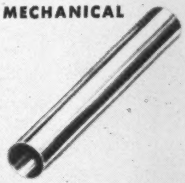
BEVERAGE — Cut Lengths or 50′ Coils

MECHANICAL



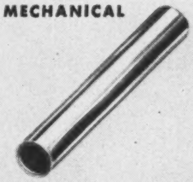
FULL FINISHED — Annealed and Tested for All Mechanical Uses — All 300 Series Analyses

MECHANICAL



ORNAMENTAL — Type 302 — Not Annealed — Not Pressure Tested

MECHANICAL

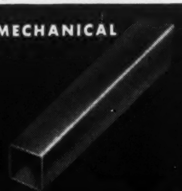


STAINLESS CLAD — Double Wall — Outside Stainless — Inside Carbon

STEEL TUBING

1/8″ O.D. THROUGH 6″ O.D.

MECHANICAL



STRUCTURAL—Squares, Rectangles and Special Shapes within periphery of 1″ thru 20″

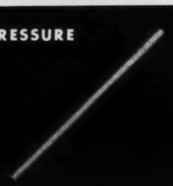
PRESSURE

HEAT EXCHANGER AND CONDENSER — To A.S.T.M. — A-214 — To Customer's Special Specifications

PRESSURE

BOILER TUBES—To A.S.T.M. A-178 and Government Specifications

PRESSURE



HYDRAULIC LINE — 3/8″ O.D. and Larger

REFRIGERATION

REFRIGERATION—Complete Size Range

MECHANICAL

FABRICATION — All Types of Fabrication Available

SIZE—GAGE RANGE CHART ROUND TUBING

Outside Diameter of Tube	Wall Thickness (B. W. Gage)	
	Carbon Steels	Stainless Steels
	Mechanical Tubing	Mechanical Tubing
1/4″	....	16-25
3/8″	18-22	16-25
7/16″	16-22	16-25
1/2″	16-22	14-25
9/16″	14-22	14-25
5/8″	14-22	14-24
11/16″	14-22	14-24
3/4″	9-22	13-24
13/16″	9-22	13-24
7/8″	9-22	12-23
15/16″	9-22	12-23
1″	6-22	11-23
1 1/16″	6-22	11-22
1 1/8″	6-22	11-22
1 3/16″	6-22	11-22
1 1/4″	6-22	11-22
1 5/16″	6-22	11-20
1 3/8″	6-22	11-20
1 7/16″	6-22	11-20
1 1/2″	6-20	10-20
1 9/16″	6-20	10-20
1 5/8″	6-20	10-20
1 11/16″	6-20	10-20
1 3/4″	6-20	10-20
1 7/8″	6-20	10-20
2″	6-20	9-20
2 1/16″	6-20	.....
2 1/8″	6-20	9-20
2 3/16″	6-20	.....
2 1/4″	5-20	9-20
2 3/8″	5-18	8-20
2 1/2″	5-18	8-20
2 9/16″	5-18	.....
2 5/8″	5-18	8-20
2 3/4″	.250″-18	8-20
2 7/8″	.250″-18	8-20
3″	.250″-18	8-20
3 1/4″	.250″-18	8-16
3 1/2″	.250″-18	8-16
4″	.250″-16	8-16
4 1/8″	14-16	.....
4 1/2″	.250″-16	8-16
5″	.250″-16	8-16
5 1/2″	.250″-16	.....
6″	.250″-16	.....

Above are common available sizes. Intermediate sizes also available. Tubes are manufactured by several processes in accordance with the size-gage ratio; therefore not all sizes and gages are readily available in all grades of product. Please contact your nearest Steel and Tubes Division Representative for delivery information on specific size, gage, and grade desired.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION
DEPT. C-7682
296 EAST 131ST STREET • CLEVELAND 8, OHIO

Please send additional information on the following:

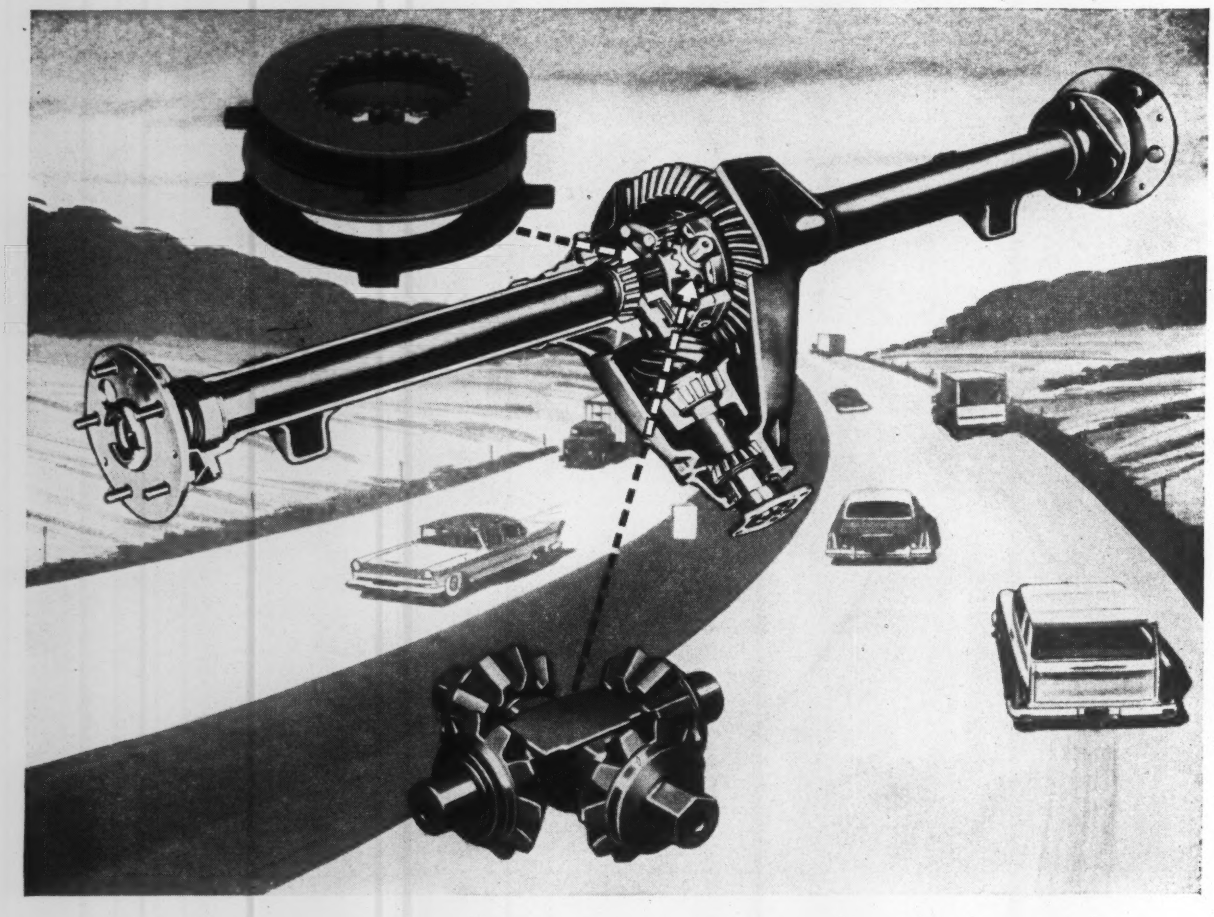
☐ Stainless Steel Tubing . . . Type__________
☐ Stainless Steel Pipe . . . . Type__________
☐ Carbon Steel Tubing . . . . Type__________
☐ Please have a Republic Engineer call.

Name____________________Title__________
Firm______________________________
Address____________________________
City________________Zone_____State________

For more information, turn to Reader Service card, circle No. 567

Problem-Solving Products from Republic

PROVIDE SUPER TOUGHNESS AND STRENGTH AT CRITICAL POINTS IN AUTOMOTIVE DIFFERENTIALS



Modern passenger cars with increasing horsepower present problems in high speed stability and handling. The Powr-Lok differential, developed by the Dana Corporation, Toledo, Ohio, permits an automotive axle to transmit the greatest driving force to the rear wheel having the better traction.

Essential to the economical and dependable operation of these differentials are Republic Alloy Steels. Why? Because only alloy steels have the high strength, toughness, shock-resistance, and abrasion-resistance needed to withstand the severe service to which differential clutch rings and side gears are subjected.

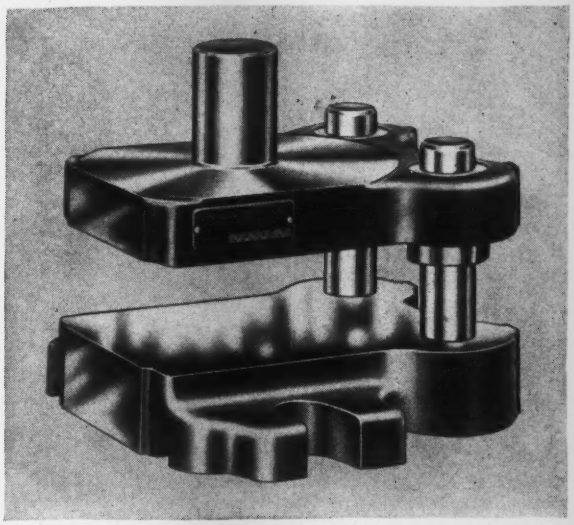
By specifying Republic Hot Rolled 8615 Alloy Bars, Dana engineers have reduced the possibility of a mechanical breakdown to an absolute minimum.

These fine steels offer superior toughness and strength to withstand torque, fatigue, shock, and stress. Alloy steel's uniform response to heat treatment gives these rings and gears hard surfaces around tough cores providing maximum resistance to abrasion, friction, and wear.

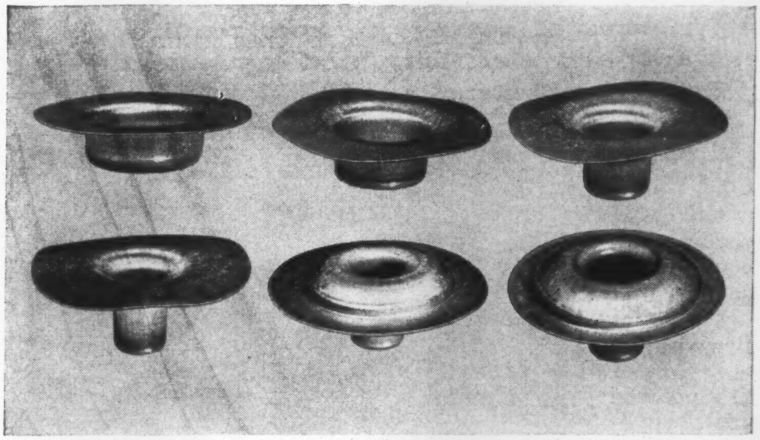
In Republic Alloy Steels you will find highest strength values—plus an exceptionally high strength-to-weight ratio that permits the designing of thinner sections to save weight and hold down size without any sacrifice of needed strength.

Republic's 3-Phase Metallurgical Service—field, mill, and laboratory—is always available to help you apply these quality alloy steels to your product. It's confidential. There's no obligation. Send coupon for more information.

REPUBLIC'S NEW HIGH STRENGTH POWDER, TYPE H. S. 6460, opens the way to new markets for new applications using sinterings for highly stressed parts. Type H.S. 6460 can be used with existing operating equipment. It provides a minimum tensile strength of 60,000 psi at 6.4 density as sintered, and 100,000 psi heat treated. Type H.S. 6460 maintains its dimensional characteristics after sintering—less than .004 inches per inch shrinkage from die size at 6.4 density. Available in production quantities up to and including 12 tons, or in multiples thereof. Mail coupon for technical data sheet on Type H.S. 6460 Powder.



REPUBLIC CHATEAUGAY PIG IRON meets demands for both strength and accurate machining in die sets manufactured by the Union Manufacturing Company, New Britain, Connecticut. As a result, Union has standardized on Chateaugay, low phosphorus, copper-free pig iron for maximum strength, flaw-free, easy-to-machine castings. Other superior characteristics of Chateaugay include its exceptional fluidity, even cooling, and fine dense grain structure. For complete information mail coupon.



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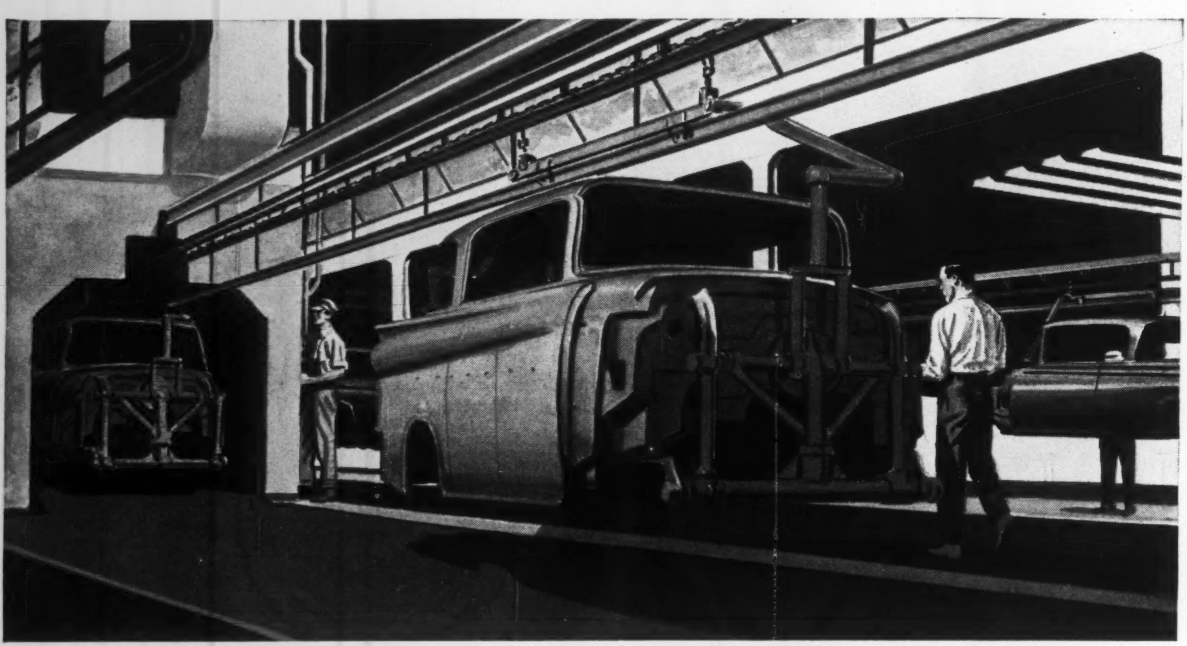


In the automotive industry alone, there are 30 Cold Bonderite installations.

How Cold Bonderite System cuts costs

Some actual user-experiences of savings in heat requirements, maintenance, water and electricity, and equipment after installing Cold Bonderite System.

Less than two years ago, the first public announcement of Parker's Cold Bonderite System was made.

Now, well over a hundred plants are using this revolutionary, money-saving system of phosphate-treating at low temperatures.

Some are among the country's largest plants, others are quite modest in size and production. Products treated range the list from automobile bodies to small appliance components.

From these users we have compiled a long list of documented savings records. In many cases, cost reductions have been greater than we had hoped to achieve.

Heat Saved

The greatest percentage savings in heat requirements (90%) has been reported by an automotive plant. Before installing Cold Bonderite System, the finishing line used 50,000 pounds of steam an hour. Cold Bonderite in the line uses only 5,000 pounds per hour.

In another auto plant, heat savings are figured at 74% on a body line. A small parts finishing line in the same plant shows the same percentage reduction in heat requirements.

The temperature tells the story! Cold Bonderite System solutions operate 60° to 75° cooler.

A manufacturer of metal cabinets reduced gas consumption for heating his phosphating line from 33,000 to 14,000 BTU per day—a 56% reduction—by installing the Cold Bonderite System.

A famous maker of household equipment changed from conventional phosphating to Cold Bonderite System and saw his steam use plummet 66%.

Another manufacturer, an Eastern small appliance maker, reports that on gas expense alone he has cut his phosphating costs 45%.

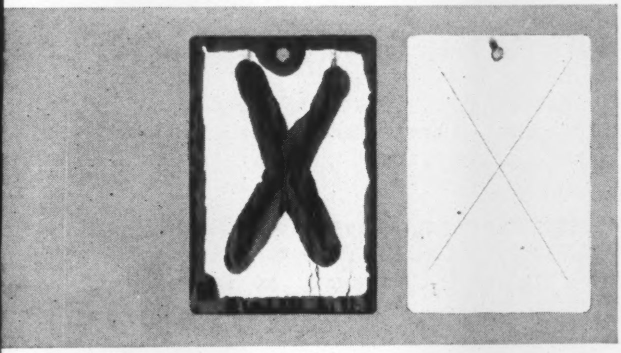
Other Savings Pile Up

The magnitude of other savings, beyond heat consumption, has been surprising to users and very good news to their cost accounting departments.

Electricity, for instance. At the greatly reduced temperatures of the solutions, there is no need to operate exhaust fans. In one installation, the change to Cold Bonderite eliminated the need for replacing a $15,000 exhaust system.

Water use is reduced about 25% because there is less evaporation.

Maintenance costs nosedive with Cold Bonderite System in the finishing line. Lower temperatures in the heating coils mean less frequent—or no necessity for—cleaning the coils. When there is service to be performed, the maintenance crew can move right in without waiting for the installation to cool off.



Comparative 48-hour salt spray test proves performance. Left, untreated panel; right, panel Cold Bonderite-treated before painting.

One user figures that he has eliminated 364 manhours of maintenance time yearly with his Cold Bonderite System.

The same manufacturer has discovered, too, that the reduced temperatures have allowed him to eliminate a number of steam traps and steam coils costing over $8,000.

Coating Quality Is High

While Cold Bonderite System is saving money on the phosphating line in these many ways, there has been absolutely no diminution of quality in the coatings or their performance.

The Bonderite coating produced by low-temperature Cold Bonderite System matches the high standards set by Bonderite for thirty years. In salt spray, humidity and outdoor exposure tests, as well as in actual service on automobiles, appliances, furniture and many other products, performance has been proven.

Results are uniform hour after hour and day after day. Control and operation of the system is simple and practically foolproof.

Chemical Costs Held Low

All the savings attained by the use of Cold Bonderite System are *real* savings. They show up on the P & L statement because *chemical costs for this revolutionary development are not increased.* The special Bonderites and Parco Cleaners are strictly comparable to conventional hot treatments in the cost of treatment per square foot.

Only Parker Has Cold System

There is, actually, no other system like it. Cold Bonderite System was developed by Parker research, tested and perfected by Parker chemists. It has been proven over and over again as the way to get superior phosphate coatings on steel with spectacular savings.

The Parker representative in your territory is ready to advise and work with you to change your phosphating installation over to Cold Bonderite System. Call him in or write direct to Parker, Detroit.

Bonderite, Bonderlube, Parco, Parco Lubrite – Reg. U.S. Pat. Off.

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IN STEEL FROM STOCK

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NEW FASTER MACHINING TUBING... Ledloy® 170—fastest machining steel tubing ever produced, average speed of 170 s.f.m. And only Ryerson has it for shipment from stock. Users report increases of 25% in productivity... longer tool life...improved finish. Sizes available to date from 1" to 2½" O.D. with maximum ⅜" wall thickness.

NOW EVEN FASTER MACHINING LEDLOY BARS... new Ledloy 375 bars boost machinability to record averages of 375 s.f.m. Large stocks of this new steel supplement Ryerson stocks of regular Ledloy 300 free-machining steels to give you widest selection. Available from Ryerson stocks in rounds from ¼" to 1", hexes from ¼" to ⅝".

TWO NEW PLANTS IN TEXAS... the former plants of Vinson Steel and Aluminum Co. in Dallas and Houston are now a part of the Ryerson organization. These plants, already well stocked and equipped, are now backed up by the unequaled facilities of the 18 other Ryerson plants across the nation. This means Texas metal users can now draw on stocks of more than 12,000 kinds, shapes and sizes of steel and aluminum. Also available, full line of industrial plastics and metalworking machinery.

NEW ALUMINUM STOCKS... are being added in Ryerson plants at Cleveland, Philadelphia and Los Angeles. Aluminum stocks at other Ryerson plants have also been greatly expanded.

NEW STOCKS OF T-1 ALLOY PLATES... in two types: to 321 minimum BNH and to firebox quality specs. "321" gives maximum resistance to impact and abrasion. Five sizes available from 3/16" through ⅝". "Firebox" is for applications requiring high strength and toughness...meets ASME code case 1204-3 for pressure vessels. Available in nine sizes from ¼" through 2". Both types offer good weldability.

STAINLESS EXTRUDED ANGLES... now available from Ryerson. They offer better surface and resultant lower polishing costs...cross-section tolerances less than half those of rolled angles for better forming into rings...no increase in price over rolled angles.

INCREASED VALUE IN STAINLESS FROM RYERSON... even though your application may not demand it in every case, you get the ultimate in specification controls when you order stainless from Ryerson—an important increased value without increased cost. Examples: in addition to chemistry specs for Types 304 and 316, you get the added value of controlled mechanical properties and Brinell hardness—and corrosion resistance assured by actual test.

STAINLESS HEADS—NATION'S LARGEST STOCK BY FAR... Ryerson stocks now include every requirement for ASME flanged and dished heads in Types 304, 304L, 316 and 316L in a wide range of gauges and sizes.

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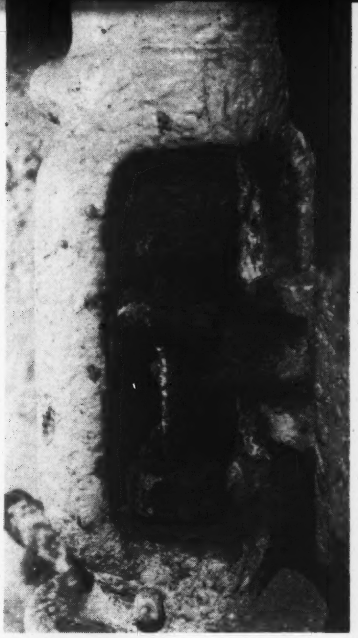


Improper selection *of materials is not always the cause of service failures.*

What Is Causing Your Service Failures?

It may be the material but . . . is the material being used the way it was supposed to be used? And are you sure the design is adequate?

by Fred J. Poss, *Service Metallurgist, U. S. Steel Corp.*

■ When a part fails in service, the physical and mechanical properties of the material are usually determined before other investigative steps are taken. This is good practice. But whether or not the material conforms to the original specifications, there should be greater scope to the investigation.

For example, suppose we find the material complies with the original specification. Without further thought we might hastily assume that the specification was inadequate and go on to tighten requirements or add new specifications. Often we will end up by substituting a more exotic material, thereby placing great emphasis on "quality" without understanding its real meaning.

On the other hand, if we find a metallurgical imperfection, however slight, it is just as wrong to immediately damn the metal as "off specification" and deem the failure "solved." The question is: Is the failure actually related to the imperfection?

What are the factors which, regardless of preliminary findings, warrant further investigation? Two of the most prominent are often overlooked—1) operating practices and 2) design details, which were previously ignored or misinterpreted.

Operating practice

A good example of misunderstood operating practice is a case in which a piece of 1½-in. type 316 stainless steel pipe failed rapidly due to corrosion in what was supposedly ½ to 1% cold sulfuric acid service. Fig 1 illustrates the application. Because stainless 316 should have been adequate for this service, chemical and metallurgical examination was made to determine the cause of failure. The corrosion attack was concentrated along the bottom of the pipe, which was perforated and paper-thin.

The laboratory confirmed that the material was stainless 316. It also noted that the pipe was butt welded and that the weld zone was centered near the bottom. No sooner had the engineers decided to stop using welded pipe than a second failure occurred. This time the weld zone was slightly offset from the *top* of the pipe section and the corrosion attack, as before, was concentrated at the bottom.

A trip to the operating area revealed the answer. The heavy, strong acid from line 2 was not getting mixed at the mixing tee. Complete mixing did not occur for a considerable distance from the tee, and in this interval the acid in the bottom of the pipe was considerably stronger than reported. Exothermic heat was also raising the temperature of the pipe wall in the region of corrosion attack.

The problem was solved by a mixing device which fed the desired composition into the handling system. The lesson learned was that an on-the-scene survey of operating conditions is often necessary.

Design inadequacy

There are at least five factors through which misunderstandings or carelessness can creep into design practice and result in failures which may later be attributed to materials failure:

1. Standard property values. These values are the result of standard tests on standard specimens and are not always dependable for design limitations. Such tests should serve only as a basis for comparing materials or evaluating the effects of various treatments. Yet it is well known that such values are used literally in design.

When tests are resorted to as a means of forecasting serviceability, results may be more misleading than informative unless the material is actually put in service and test results correlated to product standards.

2. Ideal design. The idealized concept of materials strength shown by curve *a* and bar shape *a* of Fig 2 is misleading when applied to many designs. Bars *b* through *f* and corresponding curves more closely approximate the loading found in working parts. Yet shape has tremendous influence on the strength and ductility of metals.

Good design, it is agreed, should try to avoid stress concentration and sudden change of section; in short, should try to be smooth and symmetrical like the standard tensile bar. But sharp corners, reentrant fillets and sudden changes of cross section are unfortunately necessary. Therefore a promise of good ductility by a standard tensile bar does not necessarily extend to a finished part of different geometry.

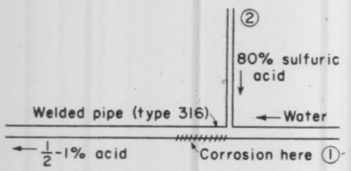


***Fig 1**—Example of operating practice causing failure. The failure was first blamed on use of welded pipe.*

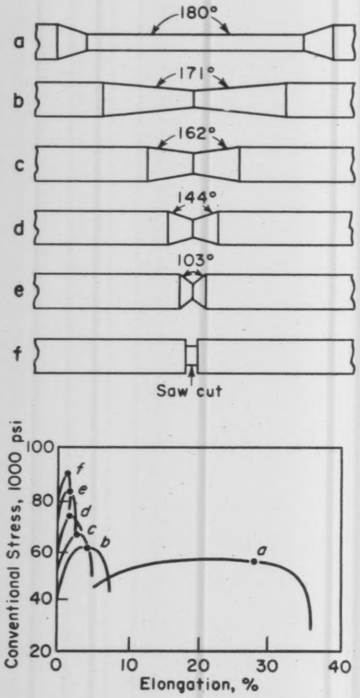


***Fig 2**—Design inadequacy often occurs because mechanical properties of "idealized" shape are extended to design shape.*

3. Service loads. Examining a large number of service failures indicates that fractures and ruptures are seldom the result of the primary service loads for which parts were designed. More often the failure was caused by bending, or by mechanical or thermal cycling. These parasitic forms of loading are present in practically any type of operating equipment that has moving parts, runs above ambient temperature, or otherwise does something useful. At local points such loads often produce stress levels that exceed the elastic properties of the materials. And, unlike the carefully spelled-out limits on static loading developed by various codes, the only real control here is the skill of the designer and of the operator.

Take bolt materials as an example of severe parasitic stresses under ordinary service conditions. In this case there are even two different codes which might be applied. One of these codes permits stressing the bolt to levels higher than the maximum set by the other.

Specifically, the ASME Pressure Vessel and Power Piping codes establish maximum allowable stresses for bolting. Low alloy steel grades, for example, are limited to 20,000 psi axial tension up to 800 F. But ASA B18.2-194 states: "The bearing surface shall be at right angles to the axis of the threaded *hole within a tolerance* of two degrees for one-inch nuts or smaller, and one degree for nuts larger than one inch."

Axial tensile stress on a bolt is the load, *p*, divided by the cross section, *a*. Stress, *s*, for eccentric loading, is: $s = p/a + p\ e\ y/I$, where *e* is eccentricity, *y* is stress radius, and *I* is moment of inertia.

For a 1-in. bolt loaded at 12,000 lb: total stress = $12{,}000/0.6 + 12{,}000 \times 0.8 \times 0.43/0.027 = 170{,}000$ psi. Thus, the axial tensile stress of 20,000 psi, although within ASME limits, is less than ⅛ the total stress; and it is the latter that is responsible for failures.

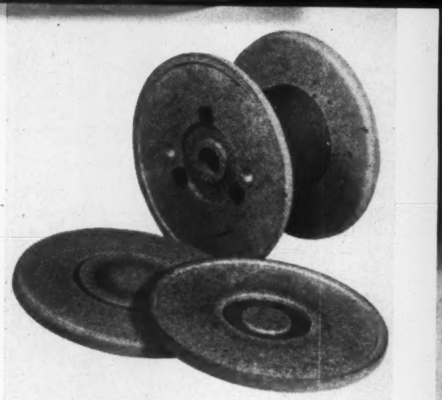
Torsional stresses may also reach high levels in bolted members. A straight line scratched along the threaded axis of a type 304 stainless steel stud was twisted to a 270-deg angular displacement after tightening the nut. Yet the bolt stress was only 11,000 psi when failure occurred by shearing.

4. Residual stresses. The temptation is strong to implicate residual stress when cracking and breakage of metal parts occur, particularly if the external overloads are not immediately obvious. It is true that the failed piece probably did have residual stresses. But fracture is related not so much to stress as to strain; stress has little bearing except as a necessary preliminary to strain. Stress, residual or otherwise, does not cause significant changes in properties. But with increasing strain, such changes do take place.

Of course, conditions do exist under which residual stress may have an influence on fracture. Such an influence might occur where yielding was inhibited, as in a notched steel bar below its impact transition temperature. But in general, external loads capable of inducing a small plastic strain will relieve most of the original residual stress.

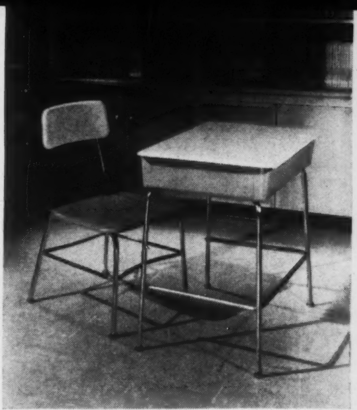
5. Overdesign. The idea that failure is directly associated with primary or design loads leads to overdesign as a means of reducing stresses, but overdesign may actually aggravate the tendency to failure. In many cases, we design to static concepts based on resisting internal pressure or axial tension. Possible errors of omission and arithmetic are compensated for by adding more metal. But the chances of brittle fracture, impact damage and notch sensitivity *increase* with wall thickness.

The designer-user must consider carefully what actual properties are important to the serviceability of the working part. To demand the best possible of everything is rarely justified and not always safe.



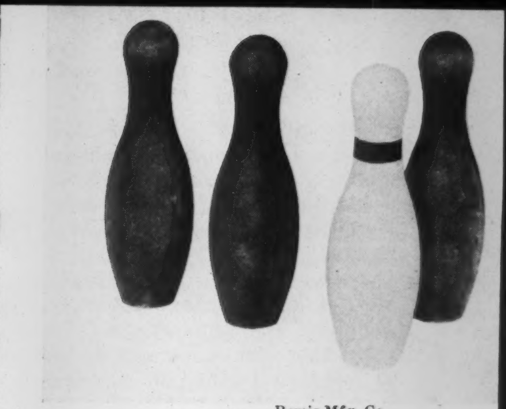
Bemis Mfg. Co.

Wire reel flanges *make use of a mixture of coarse and fine wood particles and a phenolic binder to provide adequate resistance to shock and moisture at low cost.*



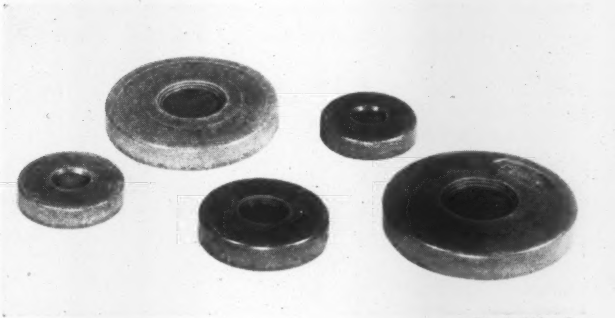
Heywood-Wakefield Co.

School furniture *components, such as desk top and chair seat and back, are molded of melamine granuplast. Material is colorful, durable and requires little maintenance.*



Bemis Mfg. Co.

Bowling pins *are produced at lower cost in granuplast, eliminating cost of turning from wood.*



Bemis Mfg. Co.

Shuffleboard disks *made of phenolic granuplast require no finishing other than flash removal.*

Bemis Mfg. Co.

Hamper tops *are economically made of molded granuplast with a decorative thermoplastic overlay.*

Do you make—or plan—parts like these? If so you should evaluate

Low Cost Wood-Particle Moldings

by Donald A. Watson, *Monsanto Chemical Co.*

■ Low materials cost, combined with a versatile range of physical properties, is the key advantage of "granuplast" moldings. Compounds contain from 60 to 90% refined wood particles, which cost about 2¢ per lb. Powdered resins used as binders cost from 21 to 43¢ per lb, depending on type.

Granuplast moldings are not comparable in properties to thermosetting plastics moldings. But properties are sufficient for many design needs and meet these needs at a low cost. Physical properties and costs can be altered widely by properly controlling variables such as resin type and content, wood particle characteristics and molded density.

Molding cycles are relatively long and mold costs are usually high ($1500 to $7500 or higher). Thus, large production volume with no design change is desirable in order to reduce per-part tooling costs and get the most out of low raw materials costs.

Pick the right binder

The resin binder should be selected with care as it is by far the costliest ingredient of granuplast compounds. The lowest priced resin that will provide needed properties should be used. The three basic types of resins used, in order of increasing cost, are urea, phenolic and melamine. Costs of compounds containing the three resins in different proportions and at various densities are shown in Table 1. Also shown are estimated costs per molded cubic foot at different densities.

Although combinations of resins can be used as binders, the following recommendations for resin selection generally apply:

1. *Use urea for low cost moldings where water resistance is not required.* Light-stable colors similar to those of the wood can be produced. For a given density and resin content, physical prop-

erties are generally lower than those of either phenolic or melamine granuplast moldings (see Table 2). Water resistance is so low that moldings cannot be painted.

2. *Use phenolic for stronger, more water resistant moldings.* Moldings are usually darker in color than the wood component and darken further on exposure to sunlight. They can be painted or finished. Water resistance is sufficiently high for moldings to be used in humid environments, but contact with water is not recommended.

3. *Use melamine for colorful, water resistant moldings with good surface gloss.* Most expensive of the three binders, melamines can be pigmented to provide practically any color but white. Colors are light-stable, and high melamine compounds provide good surface gloss and hardness. Colored blends usually have higher than 35% resin content and should be molded to densities of over 75 lb per cu ft. At lower resin contents and densities there is usually insufficient flow to produce a glossy, nonporous hard surface.

Consider physical properties

Typical properties of several types of granuplast moldings are shown in Table 2. Physical properties cannot be described as definitively as those of other plastic materials. The number of variables within and between different molding plants is too large to permit all-inclusive property descriptions. Those properties given in the table have in the past proved pertinent to granuplast applications. The values given should be used as a guide, along with the cost data, in considering such moldings as a possible answer to some of your design problems.

TABLE 1—APPROXIMATE MATERIALS COSTS

Resin Type and Content (% Total Weight)	Cost		
	$/Lb of Compound	$/Molded Cu Ft at 56 Lb/Cu Ft[a]	$/Molded Cu Ft at 81 Lb/Cu Ft[a]
UREA			
10%	0.039	2.18	3.16
15%	0.048	2.69	3.89
20%	0.057	3.19	4.62
30%	0.066	3.70	5.35
PHENOLIC			
10%	0.045	2.52	3.65
15%	0.058	3.25	4.70
20%	0.070	3.92	5.67
30%	0.095	5.32	7.70
MELAMINE			
10%	0.061	3.42	4.94
15%	0.082	4.59	6.64
20%	0.10	5.60	8.10
30%	0.14	7.84	11.34
40%	0.18	10.08	14.58

[a] Molding costs not included. Densities represent lowest and highest commonly molded in granuplast: materials costs for other densities can be estimated by multiplying cost per lb by density.

TABLE 2—TYPICAL PROPERTIES OF GRANUPLAST

Binder	Molded Density, lb/cu ft	Modulus of Rupture, 1000 psi	Rockwell Hardness (R Scale)	Water Absorption (24 hr), %	Shrinkage, in./in.
Urea (15%)	62.4	3.1-3.7	26-46	30-50	0.003-0.008
Phenolic					
10%	56.2	2.3-2.9	18-38	25-50	0.001-0.005
	62.4	3.4-4.0	37-57	20-45	—
	68.7	4.5-5.1	62-82	10-25	—
15%	56.2	3.6-4.2	39-59	25-45	—
	62.4	5.0-5.6	61-81	15-35	0.002-0.007
	68.7	6.5-7.1	73-93	5-20	—
20%	56.2	5.4-6.0	60-70	10-25	—
	62.4	6.0-6.6	66-86	5-15	—
	68.7	7.9-8.5	76-96	3-8	0.003-0.008
Melamine (15%)	62.4	3.6-4.2	37-57	15-35	0.003-0.008

To date, the highest physical properties obtained in granuplast moldings are:

Modulus of Rupture, psi	9200-9800
Rockwell Hardness	R110-R130
Izod Impact Str, ft-lb/in. notch	1.5-2.0
Water Absorption, %	1-5

In lower strength moldings, resistance to screw withdrawal generally falls between 300 and 500 lb. Maximum values depend on screw type and size as well as the method used for setting. Maximum values of 600 to 800 lb have been obtained.

Understand design problems

Materials standards for granuplast compounds are lacking, and molding procedures differ. Thus, in the early design stage the molder should be consulted in order to 1) ensure maximum moldability at minimum resin content, 2) keep tooling costs at a minimum, and 3) ensure maximum production rate of highest quality moldings.

As is the case with most plastics, and particularly with granuplast, rigid design rules are impossible. The following discussion should help you to understand 1) the nature of parts that can be produced, and 2) the design limitations of the materials.

Moldability—In general, granuplast compounds have limited flow characteristics, which restricts the complexity of design. Flow is highly dependent on resin content. In the following discussions, a distinction is made between low resin compounds (less than 20% resin) and high resin compounds (over 20% resin).

Several special molding techniques can be used to get certain effects in a part. For example, the poor flow characteristics of low resin compounds can be turned to advantage in some parts. If greater strength or durability is wanted in certain areas of a part, the molder can place additional compound in these areas, providing local increases in density and thus strength. The same local improvements can be obtained (at an increase in materials cost) by loading a resin-

What Are Granuplast Moldings?

Take refined wood particles and a synthetic thermosetting resin binder—the same raw materials used in wood composition board (see M/DE, Aug '57, p 107)—form them by compression molding and you have a granuplast molding. Birch, maple or pine are the types of wood usually used; particle size is commonly 40 to 80 mesh; moisture content usually less than 7%. Resin binders are urea formaldehyde, phenol formaldehyde or melamine formaldehyde or combinations thereof. Parts are molded at pressures of 600 to 1500 psi and temperatures of 280 to 400 F to produce densities ranging from 44 to 88 lb per cu ft.

rich compound in the area.

In heavier moldings and those using higher resin compounds, raw materials cost can be reduced by separately loading both high and low resin compounds in such a way as to provide a core of low resin compound, and a surface of high resin compound. With such a technique wood particles of 10 to 40 mesh can be used in the core compound to improve shock resistance and screw holding power. Of course, any special molding technique increases the molding cycle and the per-part labor costs.

Machined tool steel molds are recommended. Chromium plating —essential for molding high gloss melamine compounds — provides the best molded surfaces and greatly reduces sticking and staining. Bulk factor of granuplast compounds ranges from 2.5 to 6. Mold flash should be 0.010 to 0.020 in.

Size — Flat, uniformly thick moldings over about 1 sq ft in area may warp. Warpage problems become more severe with higher resin contents, thinner sections and higher molded densities. If flatness tolerances are not too severe, and if anti-warping techniques such as hot clamping are used, high resin moldings up to 4 sq ft in area can be produced.

Wall thickness—In low resin compounds section thickness may be reduced to about $\frac{1}{4}$ in. before poor flow in the mold creates problems of variable density. Maximum thickness is limited only by cycle time. In parts so large that only a one or two-cavity mold can be used, about $1\frac{1}{2}$ in. is the maximum practical section thickness from the standpoint of production costs. In smaller parts for which multicavity molds can be used, practical section thickness can be increased to 2 in. or more.

High resin compounds require longer cure times than low resin compounds. For practical cycle times and economical materials costs, section thickness should not greatly exceed $\frac{3}{4}$ in. Minimum section thickness may be as low as 1/32 in., except where melamine gloss is desired. In such cases, minimum section thickness is about the same as for low resin compounds.

Change in section thickness—Keeping thickness change to a minimum is particularly important with low resin compounds. Minimum radius of curvature on curved edges should be equal to the molded thickness. The smaller the radius the higher the density of the area, and the more brittle it will be. Ridges or bosses extending as far as $\frac{1}{4}$ in. above or below the surface of the molding can be produced.

Draw depth—Low resin compounds and melamine gloss materials should not be designed for a depth of draw greater than the change of section thickness limitations discussed above for melamine gloss compounds. High resin compounds other than melamines can provide draw depths up to 5 in. when radius of curvature is over 1 in. and wall thickness is $\frac{1}{4}$ in. or less.

Tolerances—In designing with any engineering material, specifying closer tolerances than those actually needed increases cost. In general, optimum tolerances for granuplast parts are ±0.005 in. per in. on thickness and ±0.002 in. per in. on other dimensions. Molded weight can usually be specified within ±5%. Shrinkage, of course, can be compensated for in mold design. As shown in Table 2, shrinkage increases with resin content and density.

Holes—Holes can be successfully molded in high resin compounds. Drilling after molding is preferred for low resin compounds. Holes can be easily drilled to a depth equal to three or four times the drill diameter. For deeper holes, polished flute drills with a fast spiral, 35-deg helix angle are recommended.

What about post-mold finishing?

Machining — Granuplast moldings can be sanded, sawed, drilled and (with the exception of urea compounds) painted. For high resin moldings of densities over about 59 lb per cu ft, fine grit, open-type silicon carbide tipped shapers and saw blades are required.

Fastening—Self-tapping screws provide highest strengths. Counterboring screw pilot holes improves shock resistance of a mounted assembly. When coarse wood particle cores are used in dense, high resin compounds, screws must be located far enough from the edge of the part to penetrate the core material. Although granuplast moldings cannot be nailed without splitting, low resin compounds can be stapled.

Coating — Primers or sealers should be applied before coating with lacquers or baking enamels. Specially compounded coatings are also available for granuplast moldings.

Acknowledgments

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Headed Parts

- *What Materials to Use*
- *How to Design Them*

by Richard B. Belford, *Technical Advisor, Industrial Fasteners Institute*

Proper use of cold and hot heading can reduce cost of parts and improve dimensional tolerances.

TABLE 1—MATERIALS AND TYPICAL PROPERTIES OF FINISHED PARTS

IFI Grade	Nominal Composition, %	Mechanical Properties			
		Ten Str (min), 1000 psi	Yld Str (min), 1000 psi	Hardness	
				Brinell	Rockwell
CARBON AND ALLOY STEELS					
S 0	Steel	—	—	—	—
S 1	Steel, Low Carbon	55	—	207 max	B95 max
S 2	Steel, Low Carbon	55-69	52-55	241 max	B100 max
S 3	Steel, Medium Carbon (cold worked)	90-110	70-85	187-269	B89-104
S 5	Steel, Medium Carbon (heat treated)	90-120	55-85	183-302	C19-32
S 8	Steel, Alloy	150	120	302-352	C32-38
S 10	Steel, Low Carbon (annealed)	—	—	—	B60 max
STAINLESS STEELS					
SS 1	Cr 11.5-13.5	80	40	160-190	B74-88
SS 2	Cr 17	75	35	154 min	B82 min
SS 3	Cr 18, Ni 8	75	30	154 min	B82 min
COPPER AND COPPER ALLOYS					
C 1	Cu 99.92	32	10	—	—
C 2	Cu 90, Zn 10	45	30	—	—
C 3	Cu 63-70, Zn	45	20	—	—
C 4	Cu 95-96, Si 1.5-3.75	56-70	25-35	—	—
ALUMINUM AND ALUMINUM ALLOYS					
A 1	Al 99 min	13	5	—	—
A 2	Cu 4, Mg 0.5, Mn 0.5	62	40	—	—
A 3	Cu 4.5, Mn 0.6, Mg 1.5	68	46	—	—
NICKEL AND NICKEL ALLOYS					
N 1	Ni 99.4	68	20	—	B76 min
N 2	Ni 67, Cu 30, Fe 1.4, Mn 1	75	35	—	B81 min
N 3	Ni 77, Cr 15, Fe 7	80	25	—	—

■ Heading is an automatic hot or cold forging operation. The most common products are standard bolts, screws, rivets, nuts, nails and similar parts. However, heading is not limited to producing these simple shapes. It can be used for forming collars, tapered parts, knurled parts, projections and fins. The operation is discussed in a box on p 108.

Materials

Selection of the material is important in the design of a headed part. Basically, the proper material is the one that performs the required service at lowest cost. It is usually found that several materials will satisfy the service requirements, but these materials may vary widely in processing properties, availability and cost.

The Industrial Fasteners Institute has selected 20 grades of materials for heading that will generally fulfill service requirements. The grades include seven carbon and low alloy steels, three stainless steels, four copper alloys, three aluminum alloys and three nickel alloys. Expected properties of parts produced from each grade are given in Table 1.

Steels

Low carbon steels—In the heading industry, all carbon steels having carbon contents too low to respond readily to heat treatment are considered low carbon steels. These steels (S 0, S 1, S 2, S 10) are easily headed, have good strength properties and can be case hardened.

Medium carbon steels—Medium carbon steels can be cold worked fairly readily, but their ability to be headed decreases with increase in carbon content. These steels (S 3, S 5) can be heat treated to improve properties, and in the heat treated condition offer the most strength per dollar of any known material.

Alloy steels—Alloy steels are produced with such alloying additions as molybdenum, nickel, chromium, vanadium and silicon to improve hardenability, toughness, and resistance to loss of strength at high temperatures. After heat treatment, the alloy

Notes
Typical steels: C1010, C1015, C1018, C1115, C1120. No mechanical property requirements
Steels same as above. Min 55,000 psi tensile strength
Typical steels: C1015, C1018, C1020. Similar to S 1 but higher strengths obtainable by cold working small diameter material
Typical steels: C1030, C1035. Cold worked, stress relieved. Min strength 90,000 psi reached without heat treatment
Typical steels: C1035, C1038, C1040, C1045. Quenched and tempered; min tempering temp 800 F
Typical steels: 8635, 8640, 4140. Quenched and tempered; min tempering temp 800 F, min as-quenched hardness R_C47
Typical steels: C1006, C1008, C1010. Annealed. Max hardness R_B60 for riveting or staking
Typical steels: 410, 416. Annealed. Good heading qualities; can be heat treated to improve strength
Typical steel: 430. Annealed. Excellent heading qualities
Typical steels: 302, 305. Annealed. Hardens rapidly during cold work, must be annealed for max corrosion resistance
Electrolytic tough pitch copper, min elec cond 101% IACS. Excellent cold and hot heading properties
Commercial Bronze, min elec cond 44% IACS. Good cold heading properties, hot heading less satisfactory
Heading Brass, elec cond 27-28% IACS. Most widely used brass in heading industry
Silicon Bronze, elec cond 7-12% IACS. Considerably stronger than other copper grades
1100-O, elec cond 57% IACS. Excellent cold and hot heading properties, but low strength
2017-T4, elec cond 30% IACS. Good cold and hot heading properties. Can be heat treated to improve strength
2024-T4, elec cond 30% IACS. Good cold and hot heading properties. Can be heat treated to strength higher than A 2.
Nickel, annealed. Good cold heading, excellent hot heading properties
Monel, annealed. Good heading properties
Inconel, annealed. Difficult to cold head, but can be hot headed readily

steels (S 8) are more uniform in properties than the carbon steels but are also more expensive and more difficult to work.

Stainless steels—Three stainless grades are specified, one a heat treatable grade (SS 1), the others to be used in the worked or annealed condition (SS 2, SS 3).

Nonferrous metals

Copper, brass, bronze—Copper and its alloys are used extensively in headed parts. The four grades include electrolytic tough pitch copper (C 1), commercial bronze (C 2), heading brass (C 3) and silicon bronze (C 4).

Aluminum and its alloys—Heading grades include commercially pure aluminum (A 1) and two alloy grades (A 2, A 3).

Nickel and its alloys—Although this group of alloys generally has better properties than the other nonferrous alloys included in this selection of heading materials, the nickel alloys (N 1, N 2, N 3) cost more. As a result, their use is restricted to applications requiring their special properties, such as resistance to heat and corrosion.

Design

The heading operation requires that the metal flow plastically into the size and form desired. The ability to form a head satisfactorily depends on the characteristics of the metal being headed. Following are some of the general principles of design for heading, based on the workability of low carbon steel:

Volume of material in the head

"Volume" in the heading industry is the mass of material upset. This mass is expressed in diameters (see Fig 1), and the formula for calculating the number of diameters in the upset is:

$$\text{Diameters in upset} = \frac{D^2H}{d^3}$$

where D = dia of upset portion
H = height of upset portion
d = original dia of rod

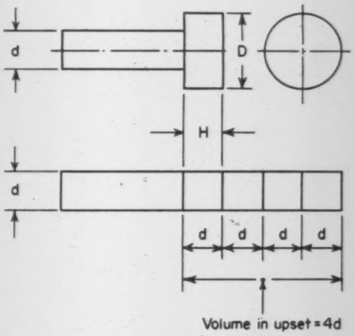


Fig 1—*"Volume" is the mass of material upset given in diameters.*

Heading: its advantages . . .

1. Parts need not be concentric.
2. Low scrap losses.
3. Grain flow during forging contributes to strength.
4. Cold headed parts have smooth, bright surface; often require no additional finishing.
5. Operation reveals hidden defects in the stock.
6. Excellent for long production runs.

. . . and limitations

1. Cold heading limited to relatively small diameter parts.
2. Shapes somewhat limited.
3. Permissible upset limited by properties of material.
4. Long runs required for economical operation.

The practical limit of length that can be upset with one blow is 2¼ diameters. In multi-blow upsetting, the number of blows required to complete the heading operation is, for practical purposes, one-half the total number of diameters in the upset. Fig 2 shows the relationship.

In hot heading, heat losses influence the number of blows that can be struck effectively before reheating is required. In general, stock *less* than 1 in. in dia can be struck 3 blows; stock *over* 1 in. in dia can be struck 4 blows.

For either hot or cold upsetting, the head volume and the quantity

TABLE 2—TOLERANCES ON SHANK AND SHOULDER DIAMETERS

Nominal Shank Dia, in.	Tolerance Range[a], in.		
	Type 1	Type 2	Type 3
⅟₁₆ through ³⁄₁₆	0.008	0.004	0.002
¼	0.010	0.005	0.0025
⁵⁄₁₆	0.012	0.006	0.003
⅜	0.013	0.006	0.003
⁷⁄₁₆, ½	0.015	0.007	0.0035
⁹⁄₁₆, ⅝	0.017	0.008	0.004
¾	0.018	0.009	0.0045
⅞	0.020	0.009	0.0045
1	0.022	0.010	0.005

[a] Tolerance ranges can be ±, + or — although it is recommended that they be — if possible. Type 1 tolerances can be held easily and should be specified if possible. Use of tolerances closer than Type 2 often requires secondary operations.

TABLE 3—TOLERANCES ON HEADS

Nominal Shank Dia, in.	Tolerances[a]	
	For Upset Height, in.	For Upset Dia, in.
⅟₁₆	0.008	0.014
⅛	0.010	0.018
³⁄₁₆	0.012	0.021
¼	0.014	0.025
⁵⁄₁₆	0.015	0.029
⅜	0.017	0.032
⁷⁄₁₆	0.019	0.036
½	0.020	0.040
⅝	0.025	0.048
¾	0.028	0.055
⅞	0.032	0.062
1	0.036	0.070

[a] Tolerances are preferably ± but may be + or —.

TABLE 4—TOLERANCES ON LENGTH

Length, in.	Tolerance[a], in
FOR DIA UP TO AND INCL ¾ IN.	
Up to 1	⅟₃₂
1 to 2	⅟₁₆
2 to 6	³⁄₁₆
Over 6	³⁄₁₆
FOR DIA OVER ¾ IN.	
Up to 1	⅟₁₆
1 to 2	⅛
Over 2	³⁄₁₆

[a] Tolerances are ±.

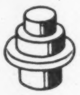
How Headed Parts Are Made

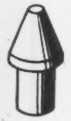
The heading operation is performed in a forging machine. The protruding end of the blank is struck one or more blows by forming hammers, after which the part is ejected automatically.

In cold heading the stock, usually a wire coil or a rod, is fed into the machine at room temperature, with the header running continuously. The smallest cold header will produce parts at the rate of 250 to 420 parts per min from wire down to 1/16 in. in dia. Production rate decreases with increasing size. Larger machines handle rod 1 in. in dia at production rates of 50 per min. Generally, the longest part that can be headed is 6 in.

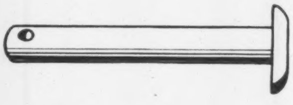
In hot heading, operation is similar to cold heading except that the stock is preheated, the temperature depending on the material. Hot heading is used for diameters too large for cold heading or for heading bars more than 6 in. long. Production rates for hot heading on automatic machines are generally 80 to 120 parts per min, but simple shapes like nuts can be produced at rates as high as 225 per min. Production rates on manually operated machines depend on the ability of the operator.

Spacer stud *for automobile clutches, formerly produced on the screw machine, is now cold headed at a saving of 65% of the previous cost.*

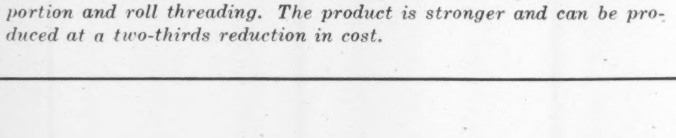




Electric sweeper part *is used to lock sweeper handle in position. This part is cold headed at a cost of $1.88 per thousand, a saving of 65% over the method used previously.*



Industrial chain pin, *made from medium alloy steel, is widely used in heavy chains. Formerly produced by drop forging or casting, the pin is now hot headed with less than 4% scrap loss.*



Mounting brace *used to adjust the height of the blades in a power lawn mower was originally produced by welding a forged eye to the end of a threaded rod and bending into the proper shape. Redesigned for cold heading, the part is now produced by heading a ball on the end of a rod, flattening the ball, drilling a hole through the threaded portion and roll threading. The product is stronger and can be produced at a two-thirds reduction in cost.*

of stock required can be determined from Fig 3.

Length of part

The length of a headed part is the distance from the end of the shank to the nearer maximum diameter of the upset. As shown in Fig 4, the length depends not only on the shape of the upset portion but also on its location. To avoid confusion, this method of specifying length must be used on all drawings.

Generally, the length specified for cold heading should lie between one diameter of the stock and 6 in. Lengths shorter than one diameter are difficult to hold and require special tooling; those over 6 in. require special equipment.

In hot heading, the length is limited by the characteristics of the equipment. Generally lengths less than 4 diameters will require secondary operations for finishing.

Tolerances

Tolerances should be specified as liberally as the application will permit. Requesting closer tolerances than are needed for proper functioning of the part unnecessarily increases the cost.

Shank tolerances—Three sets of shank tolerances are given in Table 2. Type 1 tolerances can be held easily on production equipment and should be specified if possible. Type 2 tolerances can sometimes be held on production heading machines without secondary operations, but special tooling may be required. Type 3 tolerances often require secondary operations and should be specified only where critical.

Head tolerances—Head tolerances are difficult to define because they vary with the head type. If the requirements are not critical, the tolerances shown in Table 3 can be used. If close tolerances are required, it will be necessary to consult the producer on what tolerances can be held.

Length tolerances—Tolerances that can be readily held on production equipment are shown in Table 4. Closer tolerances will increase the cost of the part.

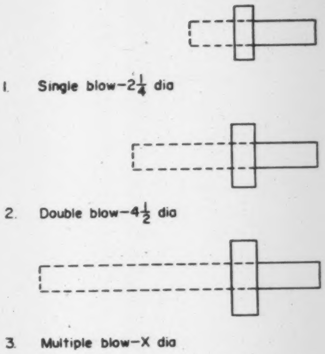


Fig 2—*Number of diameters that can be upset depends on the number of upsetting blows.*

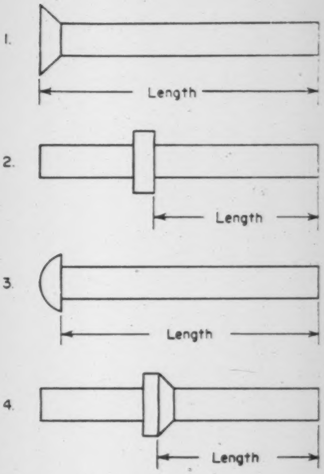
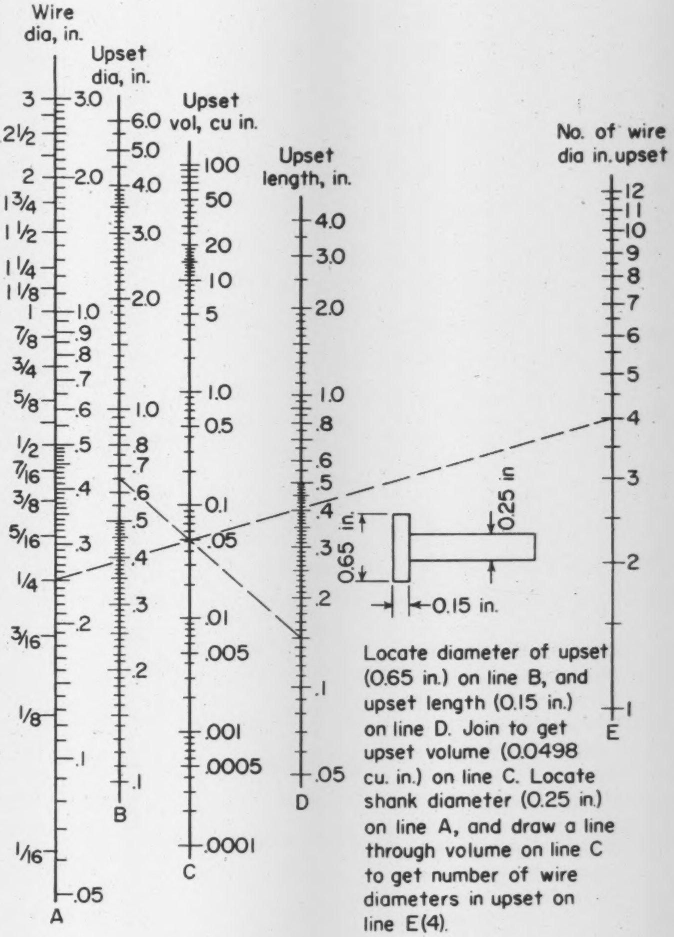
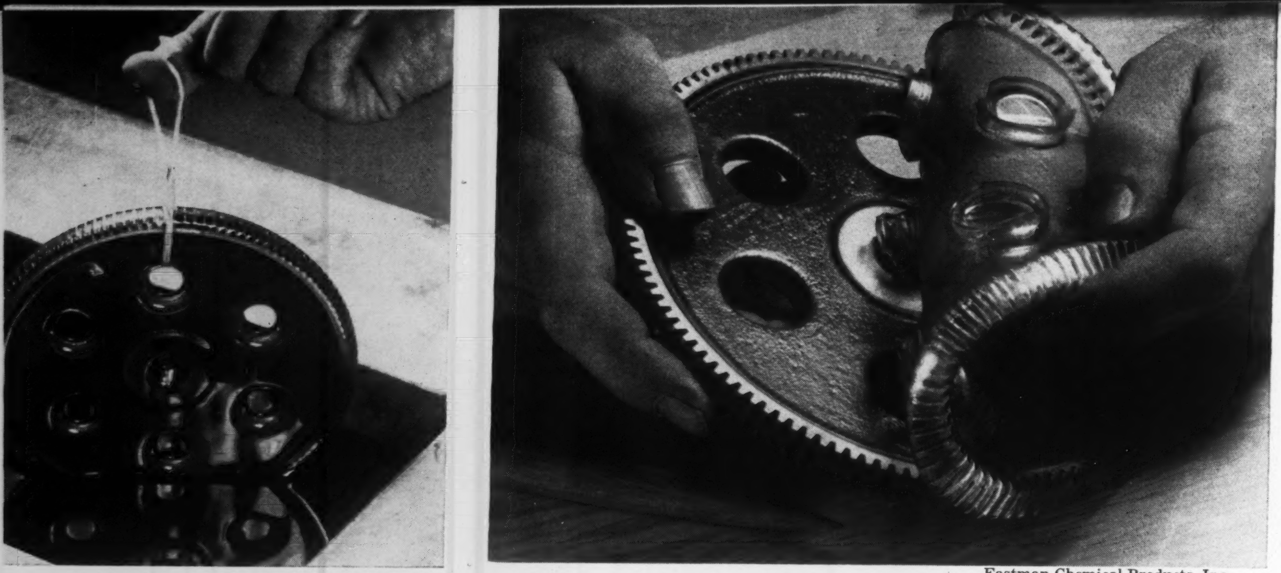


Fig 4—*Length of a headed part is the distance from the end of the shank to the nearest maximum diameter of the upset.*



Locate diameter of upset (0.65 in.) on line B, and upset length (0.15 in.) on line D. Join to get upset volume (0.0498 cu. in.) on line C. Locate shank diameter (0.25 in.) on line A, and draw a line through volume on line C to get number of wire diameters in upset on line E(4).

Fig 3—*Head form volumes and material required for a given head size are obtainable from this nomograph.*



Eastman Chemical Products, Inc.

***Hot melt cellulosic coatings** are easy to apply and remove. **Left**—Part is dipped in molten bath at about 350 F for less than 1 min. Then string is cut and hole sealed over with hot iron. **Right**—Coating is punctured with fingernail or wood stick and peeled off. Coating can be reused after melting.*

Strippable Coatings

Keep Products Bright, Clean, Safe

during manufacture, handling, shipping and storage. Properties of the most popular coatings . . . how and where they are used.

by Robert J. Fabian, *Associate Editor, Materials in Design Engineering*

■ The wide popularity of strippable coatings stems from their excellent protective properties, their low cost, and the ease with which they can be applied and removed. Coatings are available to protect a wide variety of metal products ranging from large assemblies to small, intricately shaped parts.

The majority of strippable coatings in use today can be divided into two main types, each designed for a specific kind of application:

1. Cellulosic or hot melt coatings made from celluolose esters or cellulose ethers. These coatings are designed mainly to protect small parts, such as gears, tools and valves, during handling and storage.

2. Vinyl coatings, which may be solution coatings, water-based coatings or plastisol dispersions. These coatings are designed mainly to protect larger industrial products and assemblies during both indoor and outdoor storage. They are also used to protect metal surfaces during fabrication and handling.

Cellulosic coatings

An outstanding advantage of strippable cellulosic coatings is the ease with which they can be applied and removed. Component parts or complete assemblies are simply immersed in molten cellulose plastic and then removed. The plastic completely envelopes the part and hardens into a tough, corrosion resistant protective shell.

Strippable cellulosic coatings can be made from either cellulose acetate butyrate or ethyl cellulose. In general, the properties of the two types of cellulosic coatings are quite similar. Thus, although the following discussion is derived chiefly from the literature on cellulose acetate butyrate type coatings, it applies equally well to ethyl cellulose type coatings.

Properties and cost

Strippable cellulosic coatings are mainly designed to protect parts against corrosion, impact, and dirt contamination. Practically all cellulosic coatings contain rust-inhibiting oils which combat corrosion. (It is the presence of these oils that makes the coating feel oily.) The tightness of the coating minimizes air pockets and the presence of moisture; moisture is also driven off by the heat produced during coating application. Coated parts will withstand 100% relative humidity at 100 F for 30 days with no sign of corrosion. Salt water has no effect on the coatings. Although cellulosic coatings are not completely impermeable to moisture, their success in protecting millions of parts has proved that complete corrosion protection is possible if the coatings are correctly applied. They can also be used over a temperature range of –40 to +160 F without damage.

Strippable cellulosic coatings have a tensile strength of 500 to 1000 psi and can provide high resistance to impact and abrasion. These properties are especially important during shipping and handling. The coatings in themselves provide a complete package, and delicate jet engine parts such as vanes, spline shafts and bolts need no further protection after being coated. Coated parts are simply placed in a bulk container for convenient handling. This packing method considerably reduces the cost of handling and shipping.

The transparency of cellulosic coatings permits the determination of part and code numbers and makes for easy identification. Since transparency allows parts to be easily seen, it also prevents curious tampering which can cause corrosion and contamination. The coatings are available in a wide variety of colors if required.

The cost of strippable cellulosic coatings varies from about $2.50 to $6.50 per gal, depending on the quality required. The coverage obtainable in 0.10-in. thickness is about 450 sq in. per gal. Thus, the cost of the coating may vary from 0.55¢ per sq in. (at $2.50 per gal) to 1.44¢ per sq in. (at $6.50 per gal).

How they are applied

As with other coating systems, strippable cellulosic coatings perform best when they are applied over surfaces that are free of dust, cleaning compounds or moisture. Maximum corrosion protection is obtained after vapor degreasing, removal of fingerprints and proper drying.

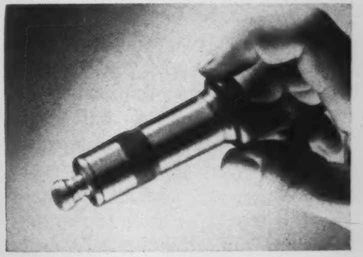
Controlling the bath—Close control of dipping temperatures and tank design is essential. Cellulosic coating baths begin to decompose above 400 F and consequently thermostatic control is necessary to prevent overheating. Melt tanks should be no larger than required to accept the largest part to be coated, and baths should be kept at 325 to 375 F, depending on the composition used. When large tanks are used the molten coating material must be circulated to prevent it from overheating at the walls. Fresh slabs of material must be added to replace the material that is removed on the parts. Air bubbles should be kept out of the bath. To prevent premature breakdown the bath should be allowed to cool and harden when not in use.

Two methods of dipping—Coatings can be applied by either of two methods. In the first method (sometimes called the double dip method) about half of the part is hand dipped in the bath, held there for about 5 sec, removed, and allowed to cool. About 35 to 60 sec is required for the coating to harden. The uncoated portion is then immersed in the bath so that the bath overlaps the previously coated portion by about 1 in. The thickness of the coating depends on the object's temperature and heat capacity, the length of dipping time, bath temperature, and rate of withdrawal. Coatings can be produced in thicknesses of 0.05 to 0.25 in. However, a thickness of about 0.10 in. usually provides sufficient protection.

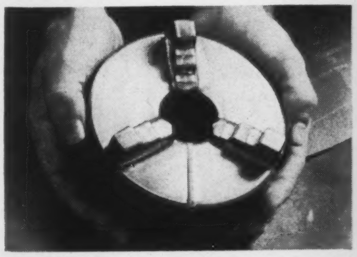
Strippable cellulosic coatings protect these parts

Photos courtesy Eastman Chemical Products, Inc.

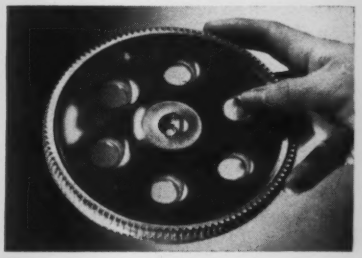
Hand tool



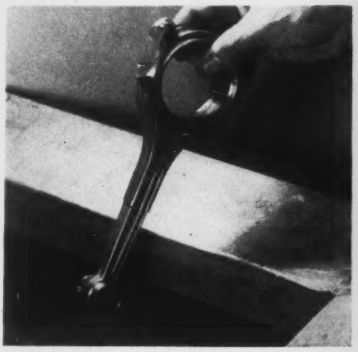
Hydraulic valve lifter



Machine tool chuck



Gear



Connecting rod

Crankshaft

In the second method (sometimes called the string tie method) the part is fastened to a looped string and totally immersed in bath. A non-wicking string should be used to prevent moisture from getting to the part. Obviously, this single dip method only takes half as much time as the double dip method. However, time and labor are required to attach the loops and to cut the string after removal. Also, the loose end of the string must usually be sealed into the cellulose film with a hot iron to keep the coating barrier intact.

Some precautions — Regardless of which dipping method is used, some precautions may be required to make coating removal easier. It is difficult to remove the coating from holes and crevices. This difficulty can be prevented by installing polyethylene plugs (see photo of crankshaft, p 111) or a foil wrap before dipping. Complicated parts such as ball bearings may be wrapped in aluminum foil to prevent the coating from penetrating or bridging the races where it would be hard to remove. However, not all holes and crevices need be plugged or wrapped as the molten coating is not thin enough to penetrate very small openings. Parts such as spark plugs with dead-end holes can sometimes be dipped so that entrapped air in the hole prevents the molten material from entering. Care is required, however, to prevent the moisture in the entrapped air from damaging the part.

In cases where there may be danger of a sharp edge cutting through the coating during handling and storage, an extra partial dip can be used to build up the film at the critical area. Another way of building up the coating at a sharp point is to hang the part with the sharp edge down so that there will be a greater build up on it during draining.

Removing the coating—When parts are ready for use the coating is stripped off after it has been slit with a fingernail or a soft tool such as a sharp wood stick that will not damage the metal. The coating material is reusable and can be replaced in the dip tank and remelted.

Where they are used

Hot melt cellulosic coatings can be applied to almost any small or medium size metal part or assembly that can be conveniently handled and dipped in a tank. Some of these parts are shown in the photographs on p 111. Typical of parts that have been successfully coated are camshafts, pistons, connecting rods, crankshafts, oil pumps, cylinder heads, bearings, bushings, sleeves, shafts, rods and pins, sprockets, various hand tools, nuts, washers, rivets, fittings, tees and elbows. It is easy to see that the variety of parts that can be coated is almost unlimited.

Vinyl coatings

The first significant application of vinyl strippable coatings took place during World War II when the coatings were used to protect cargo carried on ship decks. The heavy grease coatings that were previously used to protect parts against corrosive atmospheres took too long to clean off. The vinyl coatings could be easily stripped off at the end of the voyage.

After the war specially developed strippable vinyl coatings were used to protect military equipment (Operation Mothball) and commercial industrial products against rain, snow and sunlight for long storage periods. All of these coatings have proved extremely effective in protecting surfaces against marring and almost every form of deterioration. In contrast to hot melt coatings which are mainly used on small industrial parts, the vinyl coatings (sometimes called cold coatings) are usually applied by spraying to large objects or surfaces.

Most of the strippable vinyl coatings used today are solution coatings containing vinyl resins, a plasticizer, and a solvent. Compositions vary widely and, depending on the application, can be adjusted to provide various degrees of elasticity, tensile strength and adhesion.

Properties and cost

The distinguishing features of vinyl solution coatings are their excellent strength and elongation. Depending on product requirements, coatings can be made with tensile strengths ranging from 500 to 3000 psi. Elongations can vary from 75 to 400%, which means that some coatings can be stretched to four times their original length without damage. Elastic coatings have good resistance to impact; however, if too elastic a film is produced, it may be difficult to strip the coating off in large sheets. Also, a coating with high elongation is not too desirable where high hardness, tensile strength and resistance to abrasives are needed. The abrasion resistance of some coatings is such that a Taber abraser test using a CS-17 wheel with a 1000-mg load produces a loss of not more than 0.58 mg per 1000 rev. Also, some coatings are available that withstand bending over a 1-in. mandrel at temperatures from −32 to +180 F.

Strippable vinyl coatings have good resistance to most chemicals, moisture and water. (This statement applies only to strippable coatings that can be peeled off. Some special types of strippable vinyl coatings can be removed with water or a mild solvent.) Coatings can be formulated to resist 10% solutions of inorganic acids, bases and salts, as well as dilute sulfuric and lactic acids for extended periods. They also resist isopropyl alcohol, bleaches, soap solutions, fats and some cleaning compounds. Coatings do not have good resistance to solvents, particularly the aromatic, aliphatic, ester or ketone types. Because they contain ketone solvents, the coatings tend to attack other organic coatings. Thus, the coatings must usually be applied over bare metal surfaces. However, some types of vinyl solution coatings can be used over other organic coatings. These coatings are formulated with a smaller proportion of ketones or low boiling ketones that evaporate during spraying before they hit the surface.

Strippable vinyl solution coatings have excellent resistance to weathering. Coatings are available that can protect objects outdoors for five to seven years without any noticeable effects. Typical coatings can protect low carbon steel exposed to 95% humidity at 95 F for 240 hr. They can also withstand 250 hr of salt spray testing (ASTM B117-54T) with no signs of deterioration. Some coatings can withstand steam at 215 F for short periods. Typical permeability values that can be obtained are 15 mils—0.90 perms, 25 mils—0.55 perms, and 35 mils—0.20 perms. Maximum service temperature varies from 180 to 200 F, depending on the plasticizer used.

Coatings can provide excellent bacterial and fungus resistance and are not affected by chaetomium glaborum, myrothecium verrucaria, aspergillus niger, aspergillus terrius, penicillium citrinum and fusarium moniliforme. Coatings are also resistant to radioactivity and have been used to eliminate the washing of walls and partitions in some radiation applications. Objects are simply sprayed with a strippable coating and when it becomes dangerously radioactive (as measured by a Geiger counter) it is removed and replaced with another strippable coating.

The cost of vinyl solution coatings varies widely depending on the degree of protection required. Parts that must be protected during fabrication may require only 1 mil; parts stored outdoors may require up to 50 mils. Coatings for protecting spray booths can be obtained for as little as $2.10 per gal, whereas some of the quality coatings cost over $6.00 per gal. A very approximate cost figure can be arrived at by assuming that the coating costs $4.00 per gal and that the coverage is 225 sq ft per gal per mil. Thus, cost works out to 1.8¢ per sq ft per mil.

How they are applied

The end use of the product largely determines the method by which vinyl solution coatings are applied. Strippable coatings used to protect sheet metal during fabrication can be applied in thicknesses of 1 mil or less by spraying, rolling, dipping or brushing. For this type of application it is especially important

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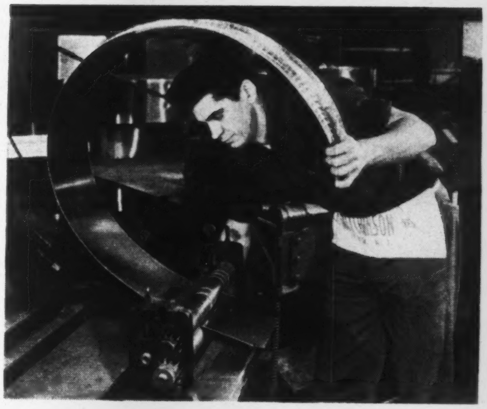
How strippable coatings protect metal during fabrication

1. Application. *A thin (½ to 1-mil) coating is applied to a stainless steel sheet before it is cut. Parts shown in these photos are intended for signs.*



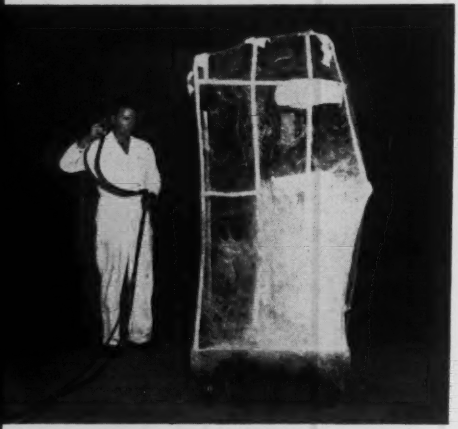
2. Forming. *A strip has been given bottom flanges and is being further formed into a complex shape. Note that the coating does not crack or buckle even after passing through the forming rolls.*

3. Removal. *Coating is being pulled from another sign section. Note the heavy scores that the coating has absorbed.*

Photos courtesy Hutchinson Sign Co., Minnesota Mining & Mfg. Co.

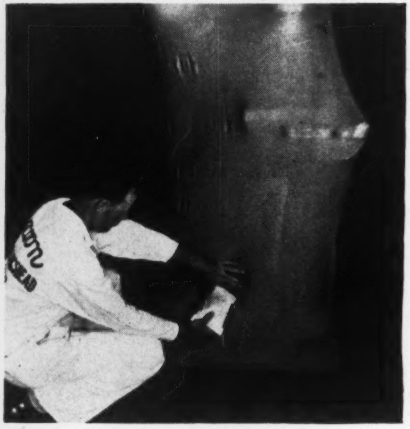
Strippable vinyl coatings are easy to use

Photos courtesy R. M. Hollingshead Corp.



1. First coat *contains webbing agent which bridges gap across tapes and provides a base for topcoats.*

2. Final coat *usually contains aluminum pigment which resists effects of sunlight during outdoor storage.*



3. Dehydrating agent *is usually inserted in protective envelope to absorb entrapped moisture.*

that surfaces be clean, dry and free of grease. Adhesion of the coating is largely dependent on the base metal used. Some general purpose solution coatings will adhere well to any metal. However, for best results the coating formulator should be consulted in order to select the best coating for the base metal being used. For example, many strippable solution coatings develop excessive adhesion on anodized aluminum, and consequently a special formulation is required for this type of porous surface.

A single thickness of 3 to 10 mils is recommended for most general uses where long exposures are not expected. However, where outdoor protection is required for several years a coating thickness of 30 to 50 mils should be used. These coatings are obtainable in a wide variety of colors, including red, olive drab, blue, dark green and aluminum, as well as clear.

When applying heavy coatings to large irregularly shaped objects the following steps should be taken:

1. Make sure that the object is clean and that all loose parts are tied down. Apply a light, inhibited oil on all surfaces.

2. Brush a sealing compound on surfaces where the coating must adhere. Pad all projections and apply tapes across all high points to provide grids of about 20 in. on a side.

3. Apply a suitable webbing agent (see photo on this page) mixture that will serve as a base for subsequent coatings.

4. Apply three coats of solution coating in thicknesses of 10 to 14 mils each. Each coat may be a different color to provide a visual check on the uniformity of coating thickness. An aluminum-pigmented final coat is usually recommended to provide protection against sunlight. This aluminum pigment tends to oxidize and flake off after continued use. Consequently, after several years the envelope may have to be recoated with the aluminum top coat.

5. Cut two holes about 5 in. square at each end of the package and drive solvents out with forced air.

6. Insert 1 lb of dehydrating agent (such as silica gel) for each 5 sq ft of area inside the protective envelope. Place a patch over each hole and respray hole.

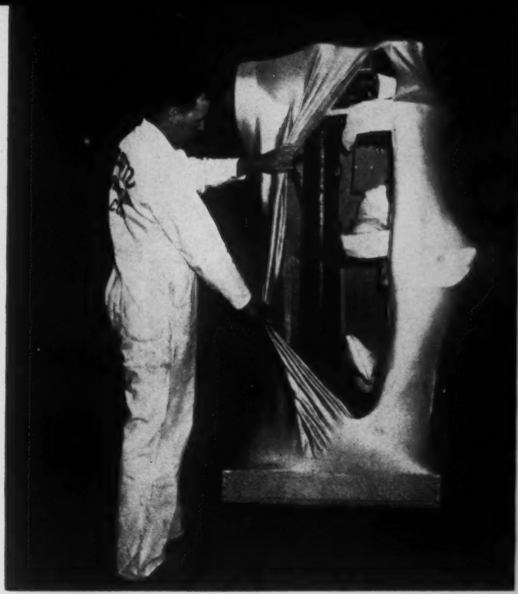
Where they are used

Protection during fabrication—A good example of how strippable vinyl coatings can protect metals during fabrication is shown in the photo sequence on p 113. The strippable coatings used for this kind of application are not recommended for use outdoors, but are especially designed for protection against marring. They can be applied to blank sheet or coil stock at the mill, in the factory before fabrication, or during the manufacturing stages. The coatings permit cupping, forming and drawing operations involving deep draws, sharp reverse bends and short radius turns to be made on sheet metal without marring its surface. The coating may be stripped off after forming or after assembly is complete; or it may be stripped off by the consumer when the product is ready to be used.

Strippable vinyl coatings are especially useful in protecting parts during transportation and handling. They have provided excellent protection for furniture, and in heavy duty architectural and building applications where they are being used to protect hardware, bathtubs, trim, molding, panels, and all types of metal equipment during installation. Most of these coatings are designed for hand stripping; however, special types are designed to be removed by water or other mild solvents.

Storage—Strippable vinyl coatings are still widely used today in the storage of military equipment. An example of their effec-

4. Flexibility *of coatings is high. Some types can be stretched three times original length before they break.*



5. Removal *is accomplished simply by puncturing coating with sharp object and ripping it off.*

tiveness occurred during the Korean War. Aircraft that had been stored for two years were made operational within 72 hr after removal of their vinyl coatings. Similarly, anti-aircraft guns were able to be fired 30 min after their coatings were stripped.

Strippable vinyl coatings are also widely used for protecting commercial products for short and long periods. These coatings are used on spray booths, machine tools, jigs, fixtures, dies, molds, and a variety of metal parts and industrial equipment. It has been reported that a major automobile manufacturer is experimenting with a strippable coating that can be applied to cars when they leave the factory, protecting them during transportation and storage.

Stop-off coatings—The use of strippable vinyl dispersions as stop-off coatings is a small, but nevertheless significant, application. The coatings are used to prevent deposition on selected areas during electroplating. They can also be used to advantage in chemical milling processes to prevent the metal from being attacked in certain areas.

In general, the properties of water-based strippable vinyl coatings are quite similar to those of the solvent-based solution coatings described above. Water-based coatings consist mainly of a water dispersion of polyvinyl acetate or vinylidene chloride plus plasticizers. The coatings may contain pigments and can be modified with a variety of resins for special properties.

The principal advantage of the water-based coatings is their non-inflammability. This property is particularly useful in reducing fire hazards and is beneficial for small companies that normally do not do much painting and want to avoid the use of potentially dangerous solvents. Another significant advantage of water-based vinyl coatings is that, since they do not contain any solvents, they can be applied directly over painted substrates without causing any damage.

Though not yet proved in all applications, water-based strippable coatings appear to be well suited for indoor uses. However, not enough experience has been obtained to say how well the coatings will perform outdoors. At present, multiple coats totaling 30 mils are recommended outdoors. However, a longer drying time between coats is required than with solvent coatings; this is especially true in humid weather. Also, the coatings have a tendency to coalesce when applied during cool weather and may even freeze if the temperature is low enough. At present, application is limited to temperatures above 40 F.

Vinyl plastisol dispersions

Vinyl plastisol dispersions have been tried in some applications but are not very widely used today. The coatings contain no solvents but they are hampered by the fact that they must be cured by baking. The coatings are also comparatively expensive and are harder to remove than other strippable vinyl coatings. However, the coatings are claimed to have good abrasion resistance. The principal use reported to date has been for the protection of automobile bumpers.

Acknowledgments

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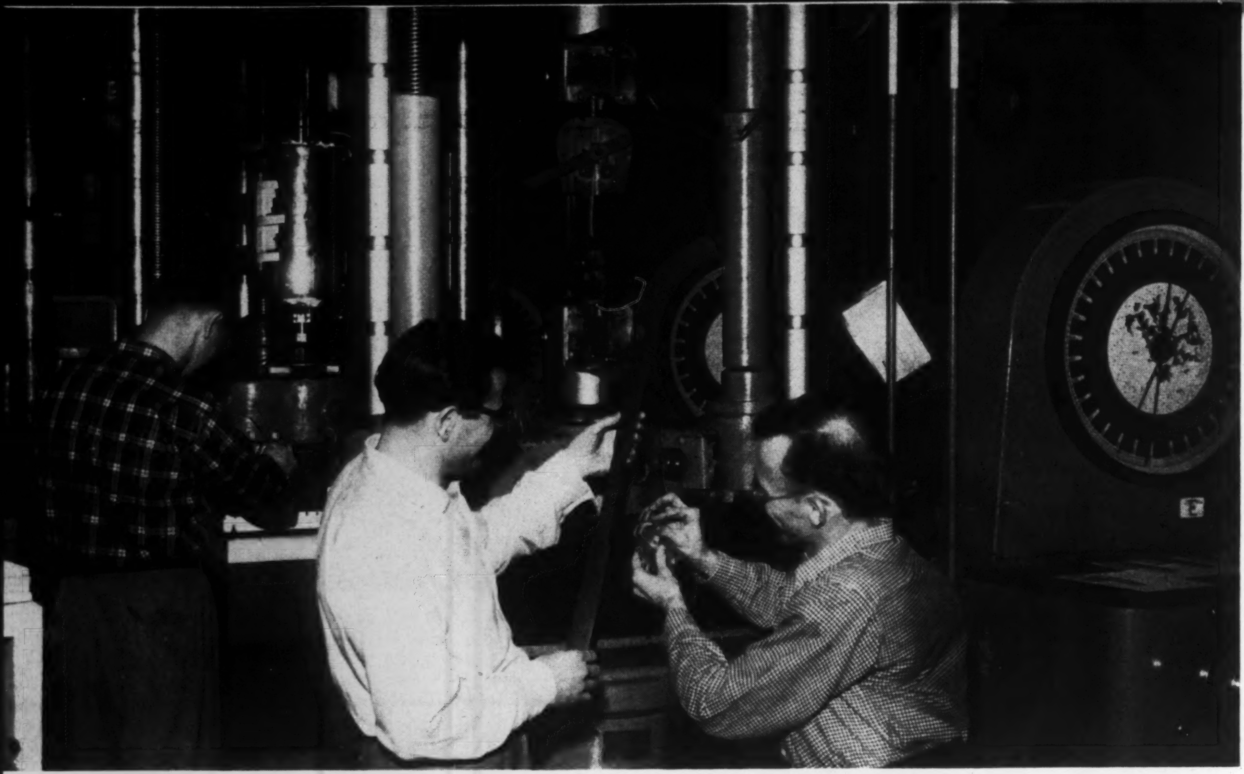
Fidelity Chemical Products Corp.
Glidden Co.
Guard Coatings Corp.
Hercules Powder Co.
Hollingshead Corp.
E. F. Houghton & Co.
Minnesota Mining & Mfg. Co.
Paisley Products, Inc.
Pyroxylin Products, Inc.
Seal-Peel, Inc.
Servwell Products Co.
Western Coating Co.



***Properties of thin foils** at high temperatures have been determined.*

How to Get the Most from Sheet Metal in High Temperature Service

Until radically new high temperature materials are developed, aircraft designers must evolve new design concepts and learn to use available materials more efficiently. This article tells how existing sheet materials can best be used for reusable manned and unmanned vehicles that have to withstand outer skin temperatures of 2000 F for 1 to 100 hr in an oxidative environment.

by Harry A. Pearl, *Chief Materials Engineer, General Engineering Laboratories, Bell Aircraft Corp.*

Multi-web beams

The properties of a material must be evaluated in terms of specific basic design. It is the function of a structure that determines whether the designer should use multi-web, Y or T beams, or stiffened or unstiffened cylinders. Each of these structures may require a different material, as the efficiency of a material depends on the end form in which it is used.

Multi-web beams + sheet skin

A special technique has been developed by design engineers at Bell Aircraft for determining the efficiency of a material for a specific type of structure. The efficiency of typical materials for multi-web beams with sheet skins are compared in Fig 1. In order to make the comparison meaningful, the materials are compared for an optimum structural design—the design that requires the least weight to fulfill the mechanical load requirements. Properties are given for exposure to temperature for ½ hr. The ordinate is an efficiency factor showing the critical stress for optimum design, divided by density—the larger the factor the more efficient the material. The abscissa is stress in psi. The curves actually show the lowest weight of available materials required for a given stress loading. When lines intersect, the lower portion of the line indicates a less efficient material. For simplicity's sake the lower portions of the lines are not shown.

Note that at 200 F magnesium is the most efficient metal for stresses up to 1300 psi, and 7075-T6 aluminum is best for stresses between 1300 and 3600 psi. At 400 F, magnesium is best up to 400 psi, 2024-T3 aluminum is best between 400 and 1200 psi, 7075-T6 aluminum is best between 1200 and 3000 psi, and titanium is best between 3000 and 4000 psi. At 1200 F, Inconel is the most efficient metal. Note also that the materials at 200 F are more efficient than those at 400 F, which in turn are more efficient than those at 1200 F.

A more useful graph can be made by combining isolines into a three-dimensional figure. Fig 2 shows the partial envelopes of optimum stresses of 7075-T6 aluminum, C-110M titanium, and Inconel X when used for multi-web beams with sheet skins. Stress is based on the relation M/h^2c, where M = bending moment, h = beam height, and c = beam width. The ordinate is the efficiency factor previously referred to. Again, the larger the factor the more efficient the material.

This graph shows the most efficient material for a particular range, or envelope, of stress and temperature. When envelopes intersect, the lower portion of one envelope depicts a less efficient area than the upper portion of the envelope it intersects. For simplicity's sake the overlapping areas are not shown. For the stresses plotted, 7057-T6 aluminum is more efficient than titanium C-110M at temperatures up to 400 F. Similarly, titanium C-110M is more efficient than In-

Efficiency of Structural Materials at High Temperatures

These graphs show the most efficient material for a given *stress loading* at a given *temperature* for a specific type of *structural design.* The materials are compared for a structure of optimum design—the design that requires the least weight to fulfill the load requirements. This design was determined by use of computers. The ordinate is an efficiency factor. The larger the factor the more efficient the material. The stress and temperature are represented by special coordinates. When lines or surfaces intersect, the lower portion indicates a less efficient material. These lower portions have been deleted to make diagrams simpler to use. Key to symbols: S = stress; M = bending moment; h = beam height; c = beam width; D = cylinder diameter.

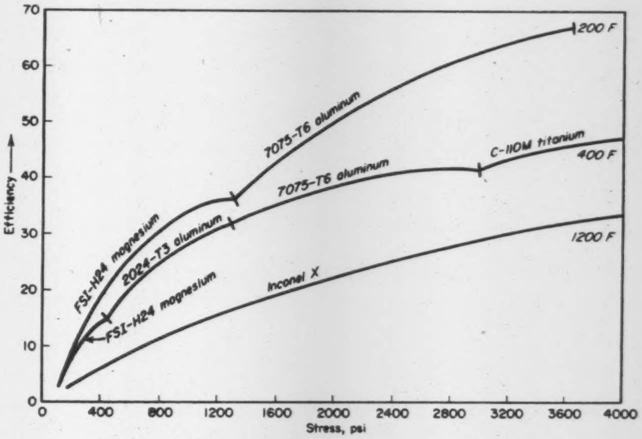


Fig 1—*Efficiency of materials when used for multi-web beams with sheet skins (two-dimensional representation). Exposure: ½ hr. Does not include creep effects.*

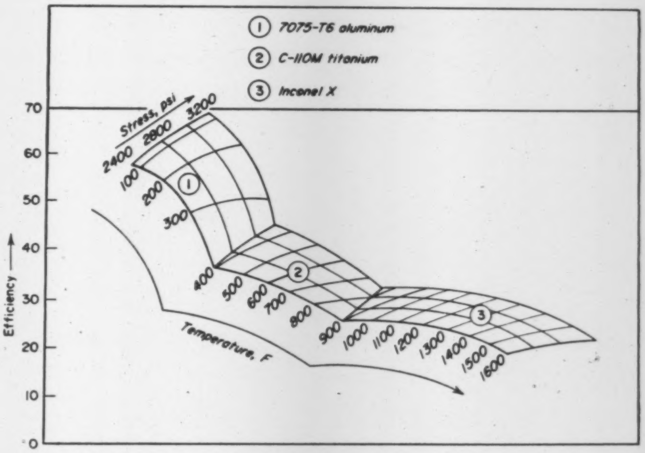


Fig 2—*Efficiency of materials when used for multi-web beams with sheet skins (three-dimensional representation). Exposure: ½ hr. Does not include creep effects.* $S = M/h^2c$.

continued

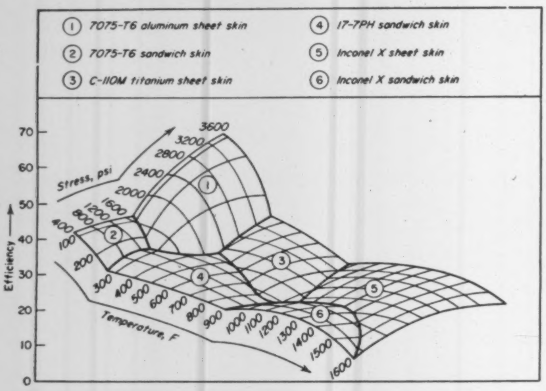


Fig 3—*Comparative efficiency of materials when used for multi-web beams with sheet or sandwich skins. Exposure: ½ hr. Does not include creep effects.* $S = M/h^2c$.

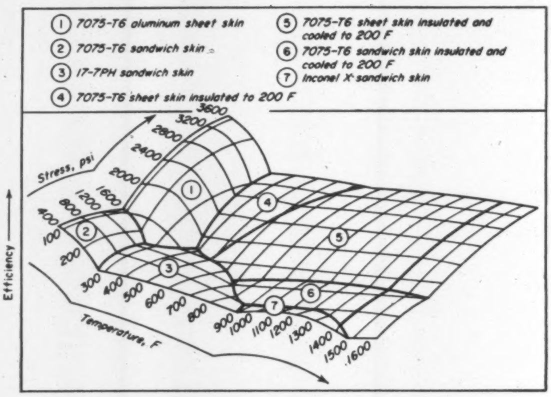


Fig 4—*Comparative efficiency of materials used for multi-web beam structures with and without cooling or insulation. Exposure: 1 hr. Includes creep effects.* $S = M/h^2c$ *(h = 7 in. for protected structure).*

conel X at temperatures up to 800-900 F.

Multi-web beams + sandwich skin

The efficiencies of various multi-web beams with sandwich and sheet skin materials are compared in Fig 3. Not shown are the continuations of areas 1, 3 and 5 which dip under areas 2, 4 and 6. From this graph it can be seen that some sandwich skins are more efficient than sheet skins where low stresses are involved. For example, in some stress-temperature areas the efficiency of a 17-7PH stainless steel sandwich skin is greater than that of aluminum and titanium skin sheet structures or aluminum sandwich structures. The 17-7PH steel sandwich was used instead of a titanium sandwich because the steel sandwich is more efficient in the subject stress-temperature area than titanium. Also, an Inconel X multi-web beam and sandwich skin structure is more efficient in limited areas than a titanium beam and sheet skin structure.

How creep affects multi-web efficiency

The effects of 1-and 100-hr creep on the efficiency of materials used in multi-web structures are shown in Fig 4 and 5, respectively. These graphs show that when creep is a factor a 7075-T6 aluminum sheet skin is good to slightly less than 300 F for high stress loadings. For a given temperature the stresses at which aluminum sandwiches are most efficient are much lower when creep is considered. Also, titanium sandwich skins are more efficient than 17-7PH sandwiches. In addition, Inconel X sandwich skins are competitive with titanium sandwiches above 550 F. Many other conclusions can be drawn by comparing these creep data with the other graphs.

Insulation, cooling may raise efficiency

From a practical point of view, high mechanical loading should be avoided at elevated temperatures. This principle leads us to the interesting idea of using thin, high-temperature-stable materials or thermal-emitting barriers in conjunction with insulation and/or cooling systems. Insulation and cooling systems can lower temperatures enough so that conventional metals can be used as the load bearing members.

Which weighs less? Insulation alone, a cooling system alone, or a combination of insulation and cooling system? Or the increase in material thickness required to maintain a given strength as temperature rises? Fig 4 and 5 show the most efficient combination of materials and cooling systems for multi-web beam structures. Note that insulation is very effective in extending the usable temperature range of aluminum. For example, Fig 4 shows that at an equilibrium outer skin temperature of 1600 F, using aluminum with an insulant and coolant to keep its temperature at 200 F is more efficient than using uncooled Inconel X sheet or sandwich structures.

The inorganic insulations that appear most suitable for temperatures near 2000 F are discussed briefly in a box on the next page.

Unstiffened cylinders

The efficiency of typical sheet materials when used in unstiffened cylinders is shown in Fig 6. The ordinate is the same efficiency factor as before. However, stress is based on the relation $s = M/D^3$, where M = bending moment and D = cylinder diameter.

The optimum stress-temperature areas of cylinders are different from those of multi-web structures. Depending on the magnitude of the stresses, aluminum is most efficient up to 350 to 400 F. Inconel X compares favorably with titanium at temperatures as low as 650 to 700 F for

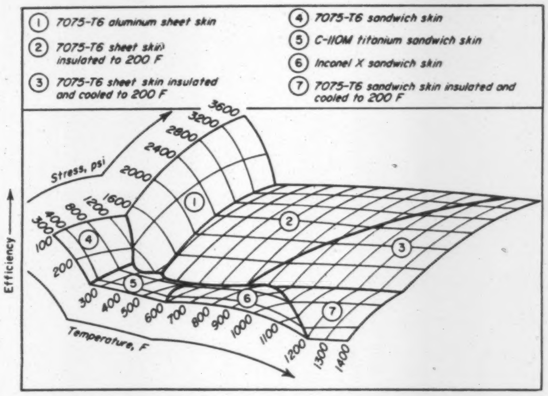


Fig 5—*Effect of 100-hr creep on efficiency of materials used for beams with sheet and sandwich skins with and without cooling or insulation.* $S = M/h^2c$.

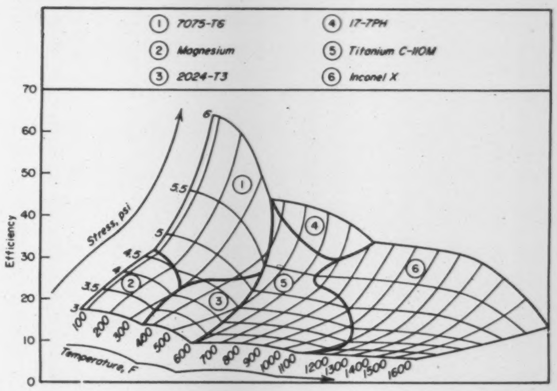


Fig 6—*Efficiency of materials when used in unstiffened cylinders. Exposure: ½ hr. Does not include creep effects.* $S = (M/D^3)^{1/3}$.

a limited range of stress values. Also, 17-7PH stainless steel is competitive with titanium and Inconel X.

Thin foils

It is expected that metal foils that are stable at high temperatures will be used as lightly loaded coverings for insulations and thermal emitting barriers. Many data are available on the mechanical and oxidation resistance properties of thick sections of metals; however, these data do not necessarily apply to metal foils. The oxidation of a few mils of metal from a 1/16 or ⅛-in. section may be inconsequential, but such oxidation can be catastrophic in thin 15-mil metal foils.

After high temperature exposure

The room temperature tensile strength of three alloy foils *after* exposure to air for 1, 24 and 100 hr, at 1600, 1800 and 2000 F, is shown in Fig 7. These data are important if we are interested in maintaining room temperature properties after the metals have been exposed to high temperatures. This information is often needed when repeated flights are to be made, but it does not tell us what we may expect at high temperatures during flight.

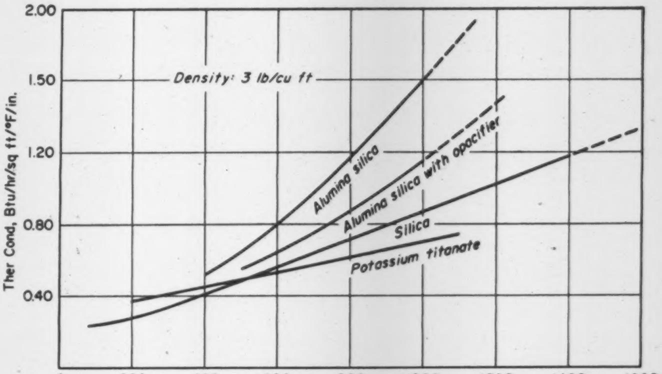
Generally, the room temperature tensile strength of all of the

Ceramic Insulations Needed at 2000 F

Only inorganic insulations appear to be suitable for use at 2000 F for periods of 1 to 100 hr. Glass or asbestos fibers melt or deteriorate excessively below 1800 to 2000 F. In contrast, fibrous ceramic insulations in densities of 3 to 20 lb per cu ft are quite suitable for use at these temperatures.

The high temperature fibrous insulations available to the designer are potassium titanate, silica, and alumina-silica systems. Thermal conductivities of these materials at a density of 3 lb per cu ft are compared in the accompanying graph. The silica insulation is made of a thinner fiber than the alumina-silica insulation and has a lower coefficient of thermal conductivity. Of the two alumina-silica insulations, the one with an infrared opacifier has the lower coefficient. The potassium titanate insulation is effective because of its thin fibers and its high reflectance.

In general, fiber insulations are more efficient than porous ceramic insulations. High temperature porous ceramics have been made from alumina, silica and various silicates. The thermal conductivity of a porous ceramic is complex and is a function of pore size and distribution, the kind of gases in the pores, and the transparency of the solid portion to infrared waves. Up to 2000 F thermal conductivity of a porous ceramic increases as porosity decreases.



Thermal conductivity *of four ceramic fiber insulations.*

alloys decreases when they are exposed to high temperatures for long periods. This decrease in tensile strength is caused by oxidation and microstructural phase changes. Similar tests conducted in argon gas show a smaller drop in tensile strength than that produced in air. Because of the absence of oxygen, the smaller drop of tensile strength in argon is considered to be due to microstructural changes only. Thus, it is tempting to conclude that the use of an oxidation-protective coating would act like argon and enable the base metal to retain high tensile strength. This conclusion is true if we are interested in maintaining high strength levels *after* exposure to high temperatures. However, it does not necessarily follow that the same coating will produce high strength levels *during* exposure to high temperatures.

High Temperature Properties of Alloy Foils

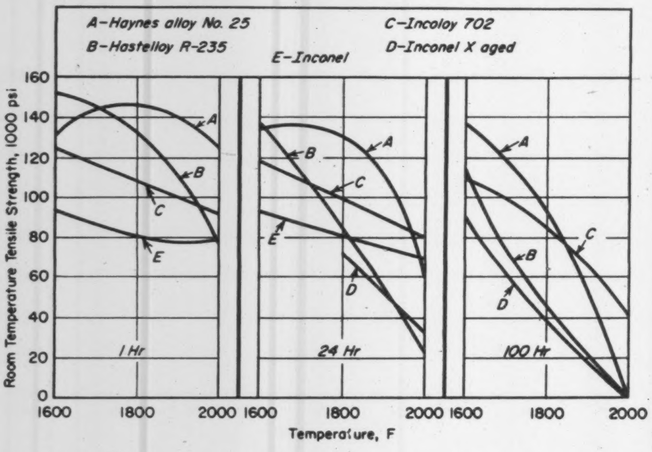


Fig 7—*Ultimate tensile strength of 5-mil alloy foils after exposure to air.*

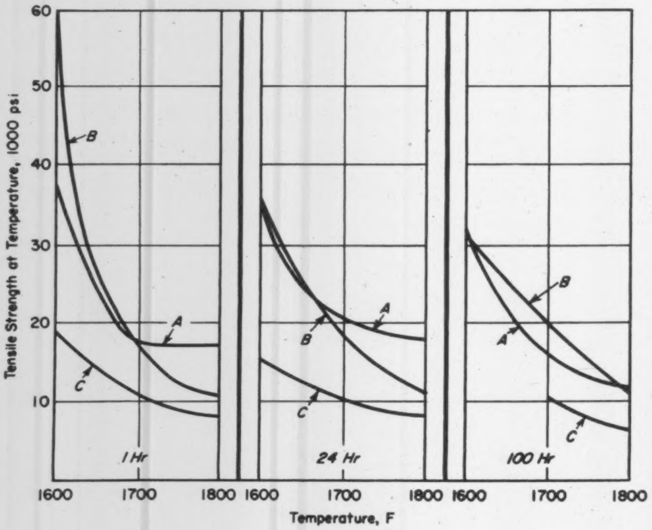


Fig 8—*Ultimate tensile strength of 5-mil alloy foils during exposure to air. For key, see Fig 7.*

During high temperature exposure

The tensile strength of three alloy foils *at* 1600, 1700 and 1800 F, and after 1, 24 and 100 hr of exposure, is shown in Fig 8. The length of exposure time above 1600 F does not greatly affect strength. However, as expected, strength decreases rapidly with temperature rise. The alloys were so badly deteriorated after exposure to 2000 F that strength tests could not be made.

Identical tests in a non-oxidative argon atmosphere have produced similar drops in tensile strength at temperatures up to 1800 F. Thus it can be concluded that the drop in tensile strength of these three alloys in air at temperatures up to 1800 F is caused not by oxidation, but by microstructural phase changes. Consequently the use of an oxidation-protective coating would not improve the properties of the foils at these temperatures.

The effects of oxidation are more marked above 1800 F. However, suitable coatings may improve the properties of Inconel 702 and Haynes 25 above this temperature. Though the properties of these foils are below usable values as primary structural materials at 1800 to 2000 F, they may be suitable for non-load-carrying purposes.

For applications requiring foil materials with greater strength at 1800 F, it is advisable to use refractory metals with higher recrystallization temperatures. Molybdenum, columbium, rhenium, tungsten, tantalum and their alloys have recrystallization temperatures of at least 2000 F. However, these metals are all susceptible to rapid oxidation and may require protective coatings. When selecting an oxidation protective coating it is advisable to select one with high emissivity. A surface with high emissivity will radiate more of the heat caused by aerodynamic heating than one with low emissivity.

Based on a paper presented before the SAE National Aeronautic Meeting, New York, Apr '58.

CUT COSTS, IMPROVE QUALITY: M/DE AWARD WINNERS TELL YOU HOW

20 Winning Entries in 3rd Annual Competition for

'Best Use of Materials in Product Design'

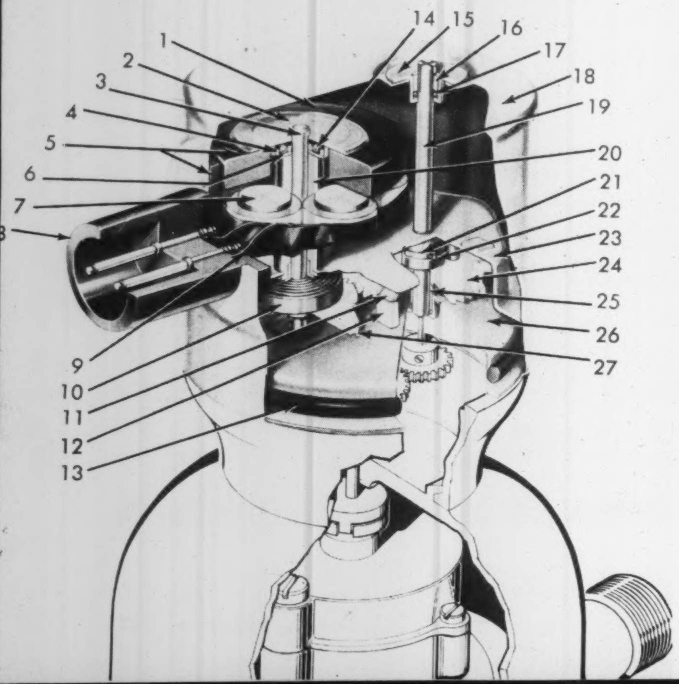
About the competition—The object of this competition is to encourage sound, imaginative and progressive use of engineering materials in the design and redesign of industrial and consumer products. The editors of this magazine impose no rigid restrictions on the procedures or criteria used by the judges in determining the award winners. However, the following factors are certainly among the most important considered: 1) importance of materials selection in the design, 2) degree of competence and thoroughness in materials selection, 3) degree of success achieved in meeting service requirements or improving old design, and 4) significance of entry in terms of setting new trends in use of engineering materials. In order to insure fair consideration of entries requiring a smaller scale of design and development than major entries, the judges split all entries into two groups, depending upon their complexity, and evaluated each group separately. Therefore, the award winning products discussed on the following pages cover a wide range of size and complexity. No entry was deemed worthy of the First Award ($500) this year, but more Awards of Merit ($100) were given than in previous years. Judges were Joseph L. Bonanno, Lionel Corp.; R. E. Fountain, General Electric Co.; Richard Schneidewind, University of Michigan; and Clarence F. Van Epps, Stromberg-Carlson Co.

HOW MATERIALS WERE SELECTED FOR METER GENERATOR

Part and Function	Materials Requirements	Material Selected
1—Permanent magnet. Provides the magnetic lines of force which are cut to induce a current in the coil windings of the generator	High ratio of magnetic strength to size, relatively high strength, low cost, ease of manufacture	Non-aging ceramic with high coercive force
2—Magnet washer. Provides surface to which magnet is cemented. Also acts as upper race for ball thrust bearing	Because of small clearances must be flat within 0.001 TIR after stamping and coining. Bearing surface must be scratch-free	Cold rolled, soft temper monel. Stainless steel could also have been used but monel could more easily be coined in available presses
3—Magnet spindle. Turns magnet. Driven by gear train from meter	High strength, impact and corrosion resistance	303 stainless steel
4—Ball retainer. Retains 3 balls of thrust bearing for magnet and spindle	Low coefficient of friction, low cost	Nylon
5—Adhesive. Bonds magnet to washer and connector to generator housing	Eliminate need for mechanical fasteners, provide sealing action	Epoxy adhesive with high strength and moisture resistance
6—Bearing race. Provides surface on which balls roll	High wear and corrosion resistance. Must be compatible with 440 stainless steel balls	302 stainless
7—Pole piece. Part of magnetic circuit	High permeability	Armco iron. Pole pieces are cadmium plated and chromate dipped for corrosion resistance
8—Connector. Provides insulated passage for electrical conductors. Also serves as mounting for electrical conduit	Good dielectric properties, moldability, good impact and tensile strength	Phenolic
9—Generator leads. Connect coil windings to connector terminals	Must be insulated and sufficiently flexible to be wrapped and taped around coils	Stranded No. 20 AWG. Ends are stripped and tinned for easy soldering
10—Impulse spring. Provides force to accelerate the magnet through 70 deg when released by the trip gear	Spring properties	302 stainless steel, spring tempered
11—Bumper. Stops gear sector after 70 deg excursion	Shock resistance	1010 steel
12—Bumper pad. Reduces shock loads imposed on bumper by gear sector. Reduces noise	Resilience, good aging properties, low cost	Modified vinyl
13—Housing o-ring. Dirt seal	Must be compatible with lubricants, adjacent materials	Buna-N rubber

Careful Materials Selection Gives Remote-Reading Water Meter 20-Year Life

***Location** of parts listed in above table.* ↓



Part and Function	Materials Requirements	Material Selected
14—Ball bearing. Reduces friction	Hardness, corrosion resistance	440 stainless steel
15—Bearing cup. Supports drive shaft bearing	Free-machining properties, corrosion resistance, solderability to mating brass parts	Yellow brass (ASTM B16-52, half-hard)
16—Drive shaft bearing	Low coefficient of friction, low cost, resistance to wear and corrosion	Nylon
17—Shaft o-ring. Dirt seal	Must be compatible with lubricants, adjacent materials	Buna-N rubber
18—Generator housing. Encloses generator mechanism	High corrosion resistance in humid atmosphere. Good deep drawing properties	Yellow brass (ASTM B36-52, alloy No. 6)
19—Drive shaft. Drive generator. Can also drive supplementary register	High strength and corrosion resistance	303 stainless steel
20—Bearing support. Supports thrust bearing and aligns top and bottom shaft bearings	Free-machining properties, corrosion resistance, formability	Yellow brass
21—Ratchet bushing. Retains drive shaft ratchet	Low coefficient of friction, low cost, high wear and corrosion resistance	Nylon
22—Drive shaft ratchet. Provides one-way drive for drive shaft	Spring properties, must be easily formed, corrosion resistance	Half-hard beryllium copper
23—Generator base plate. Mounting base for coils, pole pieces and bearing support. Also forms part of magnetic circuit	Fairly high strength, good drawing properties, low carbon content for good magnetic properties	1010 steel cadmium plated and chromate dipped for corrosion resistance
24—Trip gear. Drives gear sector and magnet	Low coefficient of friction, good wear and corrosion resistance	Nylon
25—Drive shaft bearing	Low coefficient of friction, low cost, resistance to wear and corrosion	Nylon
26—Generator housing bottom. Generator closure	High corrosion resistance in humid atmosphere. Shallow drawing properties	Yellow brass (ASTM B36-52, alloy No. 6)
27—Gear sector. Turns magnet	Low coefficient of friction. Good resistance to wear, impact and corrosion	Nylon

$100 AWARD OF MERIT

Research & Development Div., Badger Meter Mfg. Co.
Milwaukee, Wis.

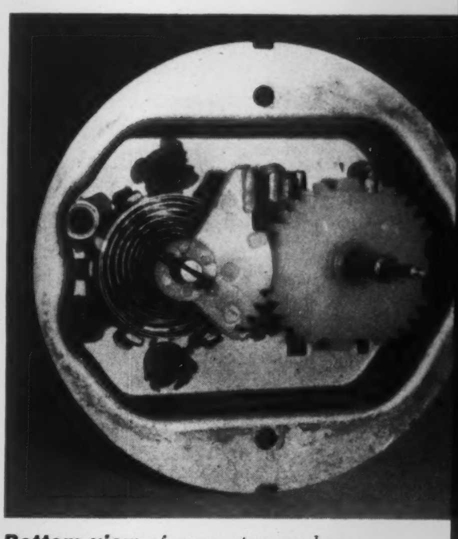
■ Two important design requirements—low cost and long life—have been satisfied in a new remote-reading water meter system. The key was careful selection of metallic and nonmetallic materials to provide high corrosion resistance, good structural strength and wear resistance, and satisfactory electrical properties.

The accompanying tables and photos show each part of the generator and register, explain its function and the materials requirements, and indicate the material finally selected after careful study.

How the system works

This system (Read-O-Matic Register) is specially designed for the remote reading of water meters. Its sole source of energy comes from the meter to which it is attached. The system consists of two separate units: an enclosed electromagnetic generator (shown on this page) and a sealed, solenoid-driven register counter (shown on the following page).

Generator—The generator at-



Bottom view *of generator mechanism showing gear sector, trip gear, spring, and register drive shaft.*

taches to a water meter in much the same way as a conventional dial register. Stamped adapter plates and screws permit the generator to be used on a wide variety of sizes and makes of meters. A drive shaft extends through the bottom of the generator, which is coupled to the meter through change gears.

The generator produces power by the loading and discharging of a permanent magnet coil system after each 90 deg of shaft rotation. The system contains an intermittent gear that drives a spring-loaded permanent magnet located in the magnetic circuit of the coil system. Each time the magnet escapes, a short, low voltage pulse is generated and transmitted to the register.

Register—The register is connected to the generator with doorbell-class wiring. The register counter is driven by a solenoid through a 40-tooth positive escape wheel and pawl. Thus, the counter shaft makes 1 rev to 10 rev of the generator spindle.

Because it operates electrically, the register can be located at any remote point up to ½ mile from the meter and generator. This feature permits the register to be conveniently read outside the house or factory or at a central reading station.

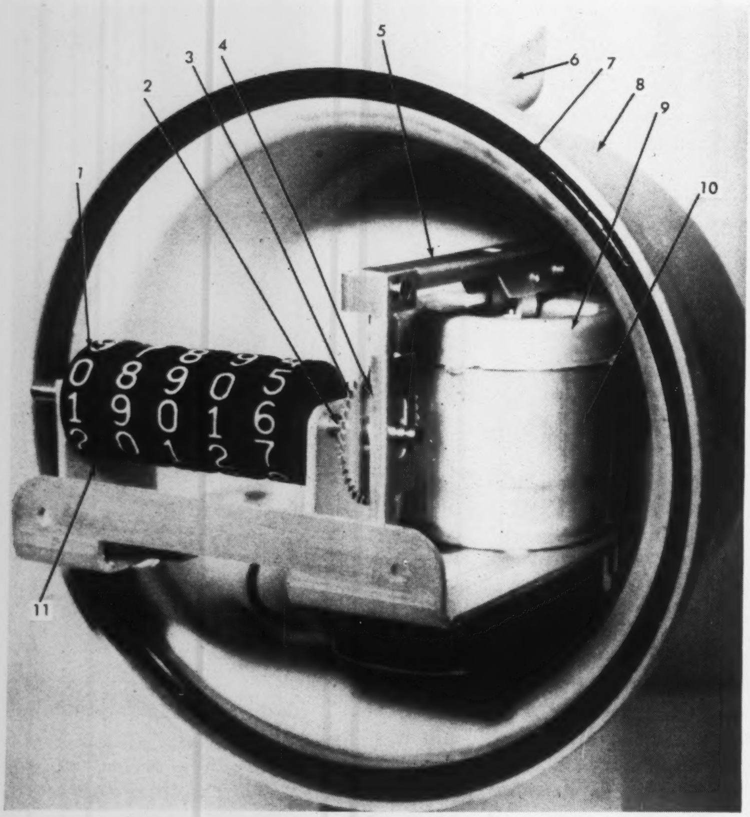
Operating requirements

The field requirements placed on the meter system parts and materials are very exacting. Not only must the system be extremely accurate but it must have a life of at least 15 to 20 years. The register must withstand weathering over a temperature range of –25 to 160 F. Although not located outdoors, the generator must operate properly after periodic water flooding (a frequent problem in some areas).

Breakdown tests on units exposed to extreme conditions have shown a very satisfactory choice of materials. A generator with its housing removed has operated under water for six months with a standard register and has accurately measured 35 million gallons of water.

HOW MATERIALS WERE SELECTED FOR METER REGISTER

Part and Function	Materials Requirements	Material Selected
1—Number wheel. Indicates volume of fluid metered	Low inertia, corrosion resistance, smooth surface, attractive appearance	ABS terpolymer
2—Counter wheel spindle. Acts as shaft for number wheel	Corrosion resistance; smooth, low friction finish	303 stainless steel
3—Ratchet wheel. Turns counter wheel spindle	Hardness, wear resistance; must be accurately formed	Half-hard brass
4—Pawl ratchet. Indexes the ratchet wheel	Light weight, rigidity, corrosion and wear resistance	2024-T4 aluminum alloy
5—Armature lever. Acts as beam to transmit motion	Dimensional stability, low inertia, corrosion resistance	5052-H32 aluminum alloy
6—Housing support bracket	Rigidity, corrosion resistance	1100-O aluminum alloy
7—O-ring. Seals housing	Weather and dirt resistance	Buna-N rubber
8—Component housing	Weather resistance, good appearance	Anodized 1100-O aluminum alloy
9—Armature cap. Part of magnetic circuit	Corrosion resistance, nonmagnetic, slight wear resistance	1100-O aluminum alloy
10—Coil cup. Part of magnetic circuit	Good drawing properties, high permeability, high corrosion resistance	1010 steel, cadmium-plated and clear chromate-dipped



$100 AWARD OF MERIT

E. T. Pfund, Jr., T. Fischer and J. Montgomery,
United Electrodynamics, Inc., Pasadena, Calif.*

Quartz, Silica Insulations Raise Temperature Limits of Coaxial Cables

■ Two inorganic electrical insulation materials—braided silica and hard quartz—are being used in a unique way in low-loss, r-f coaxial cables to permit continuous operation at temperatures of 930 F (500 C). The materials also provide high flexibility, accurate dimensional control and spacing, and improved electrical properties.

Helical braided silica withstands high temperatures

It is well known that coaxial cables with helical insulations provide the lowest electrical losses over the widest frequency bands. Ordinary helical insulations for coaxial cables are made from plastics which, unfortunately, cannot be used at high temperatures.

The problem here was to find a completely flexible, low-loss, r-f insulating material that could withstand 930 F continuously. This and other requirements are satisfied by using a tightly braided 96% silica cord (see photo) which is applied in a helix and firmly supports the inner conductor. Advantages gained with this insulation are:

Ease of application—The braided silica cord can be helically applied over the inner conductor to maintain concentricity as easily as with conventional plastics.

Low losses — A 0.375-in. dia cable insulated with braided silica has an attenuation of only 2.7 db per 100 ft at 400 mc. This value compares favorably with lower temperature polystyrene-insulated cables which have an attenuation of 2.3 db per 100 ft at 400 mc.

Increased flexibility—The density of the silica insulation permits the use of corrugated outer conductors for increased flexibility at high temperatures.

Hard quartz 'beads' permit helical construction

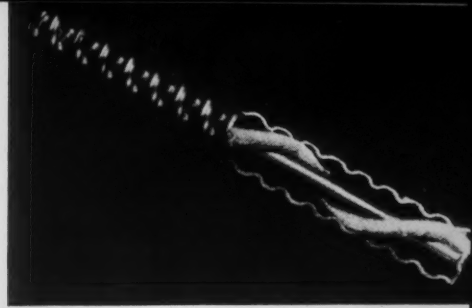
High temperature broadband coaxial transmission lines employing ceramic insulations are usually made of alumina, steatite or forsterite. These insulations are usually used in the form of disks or toroids which are spaced periodically along the line to maintain concentricity of the conductor.

The problem here was to find an extremely low-loss, high temperature insulation that could be formed into an accurate and reasonably flexible helix. These requirements were successfully met by using pure quartz bodies of ball and socket configuration (see photo). These bodies are slipped on a glass string which is then helically wound around the conductor to provide concentricity. Advantages of this insulation system are:

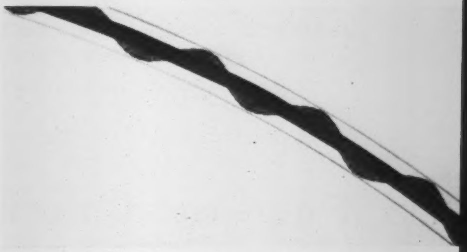
Increased bandwidth — Use of the helical quartz insulation permits a bandwidth of over 3000 mc. In contrast, conventional ceramic designs have a bandwidth of only 1000 mc.

Low dielectric constant — The low dielectric constant of quartz produces less intense electromagnetic reflections than alumina or forsterite, thereby producing a low voltage standing wave ratio (VSWR) over a broad frequency range.

Low attenuation—A 0.59-in. dia cable of quartz pearls has an attenuation of only 2.6 db per 100 ft at 1000 mc and 68 F, comparing favorably with low temperature polystyrene-insulated cables.



***Braided silica cord** insulation can be used up to 930 F, provides low electrical losses.*



***High-purity quartz** insulation used in bead form provides low losses, accurate spacing.*

Low conductor losses—Silver-clad or electroplated conductors can be used with the helical cable design to produce low conductor losses. In previous designs using periodic spacing, silver-coated conductors could not be used because the conductor had to be crimped to provide proper insulator spacing.

High operating temperatures—Silver-clad steel conductors can be used with the new helical design for continuous use at temperatures over 930 F. Previously used copper inner conductors, which had to be crimped, were limited to temperatures below 480 F (250 C) for continuous use.

Low moisture absorption—The flexible string of quartz crystals is essentially non-hygroscopic and therefore not subject to fluctuating cable losses and insulation resistance when humidity changes.

Accurate dimensions—The continuous axial support provided by the helical quartz insulation provides perfect centering of the conductor and thus constant electrical properties.

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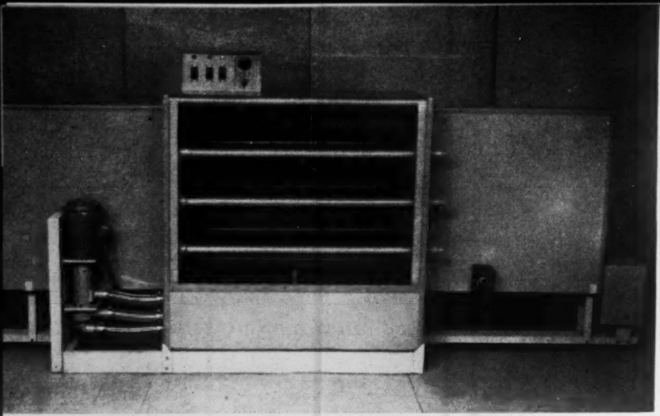
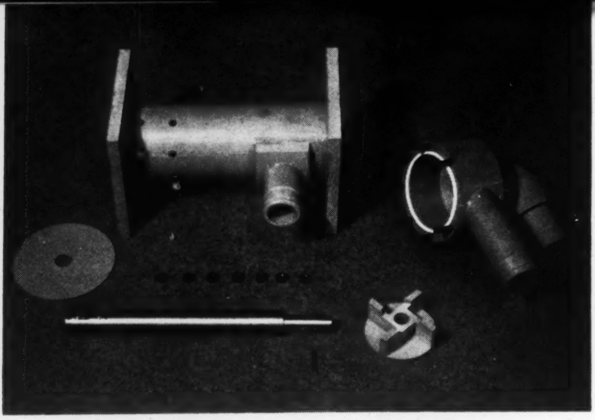
* Felten & Guilleaume Carlswerk and Andrew California Corp. also contributed.



Automatic spray etching machine *is constructed largely of polyvinyl chloride plastic. Pump is shown at left.*



Plastic pump *is made from commercially available polyvinyl chloride shapes. The shaft, set screws, housing studs and nuts are titanium. The gasket (white) is Teflon.*

Polyvinyl Chloride Meets Tough Corrosion Requirements in Spray Etching Machine

■ Tough corrosion problems were solved in the design of an automatic spray etching machine by the extensive use of unplasticized polyvinyl chloride. Titanium and TFE plastic also contributed to the success of the new design.

The etching machine is used for etching printed circuits, chemical milling, nameplate manufacturing, and stripping anodized coatings and dyes. Highly corrosive acids are used in these operations. Therefore, resistance to the etching and stripping chemicals was the first consideration in the search for construction materials.

Following this primary consideration came the factors of cost, ease of fabrication, and availability of various sizes, shapes and forms. A third set of selection factors included strength properties, maximum usable temperature, and appearance and clarity.

The Problem—CONCENTRATION AND TEMPERATURE OF ETCHANTS

Etchant ↓	Concentration	Temp, F
Ferric Chloride	42° Be	130
Ferric Chloride—Hydrochloric Acid	30-43° Be	130
Chromic Acid—Sulfuric Acid	20-30% chromic, 10% sulfuric	100-103
Hydrofluoric Acid	10%	80-100
Ammonium Persulfate	25%	80-140
Cupric Chloride (free chloride ions)	Sat. water soln	100-120

The Solution—HOW POLYVINYL CHLORIDE WAS SELECTED

Step 1—Comparing Corrosion Resistance of Metals, Rubber and Plastics[a]

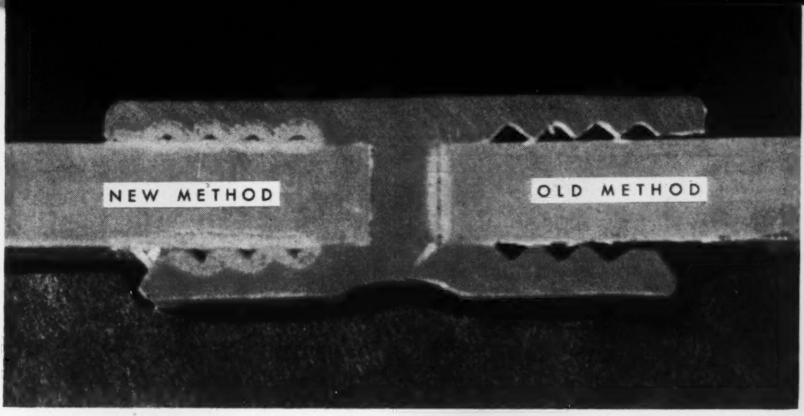
Chemical → / Material ↓	Ferric Chloride	Chromic Acid	Sulfuric Acid	Hydrochloric Acid	Hydrofluoric Acid	Ammonium Persulfate	Copper Chloride	Sodium Chloride
Stainless Steel	U	G-F	U	U	P		P	E
Hastelloy B	U	U	G	G	G			
Hastelloy C	U	G	P	F-P	G			
Titanium	E	E	E-G	F	F	E	E	E
Aluminum	U		U		P			F
Ceramics	E				P			
Carbon	E	P	E	G	P	E	E	E
Hard Rubber	G	U	G	E	E-F	G	E	E
Soft Rubber	G	U	G	E	G	G	E	E
Neoprene	F-U	U	E-F	U	U	G	G-F	E
Phenolic	E	F-U	E	E	E	E	E	E
Polyurethane	U	U						E
Nylon	U							E
TFE (Teflon)	E	E	E	E	E	E	E	E
Polyethylene	E	G	E-G	E	E	E	E	E
Polyvinyl Chloride	**E**	**E-G**	**E**	**E-F**	**E-G**	**E**	**E**	**E**

[a] E—excellent, G—good, F—fair, P—poor, U—unusable.

Why polyvinyl chloride?

The table shows in detail the service requirements that had to be met and the materials and their properties that were considered. Studying the metals listed, it is obvious that titanium was the only suitable metal from a corrosion standpoint. However, titanium was too costly and relatively difficult to fabricate. For these reasons titanium was not selected for the major components. However, it was used where its strength was needed—in the pump shafts, conveyor drive shafts and numerous small fasteners.

Of the plastics considered it can be seen from the corrosion resistance comparisons that the choice was restricted to TFE fluorocarbon plastic, polyethylene and unplasticized polyvinyl chloride (PVC). Cost considerations ruled out TFE except where its cold flow properties would be useful;



New injection bonding technique *shown on left produces stronger bond than old method.*

$100 AWARD OF MERIT

Engineering Staff, Centre Circuits, Inc., State College, Pa.

as in sealing elements. The remaining choice between polyethylene and PVC was decided in favor of PVC for these reasons:

1. It is available in many forms—large sheets, bar stock, pipe, pipe fittings, special extrusions, and manufactured items such as machine screws and nuts.
2. Several fabrication techniques could be used with PVC that could not be used with polyethylene. The most important is solvent bonding.
3. It holds a slight price edge.
4. It is available in transparent sheet stock.
5. It is stronger in both tension and compression, thus permitting construction with less support.

Self-supporting construction

Several possible construction methods could be used with polyvinyl chloride. The methods considered included steel tanks coated with PVC, thin PVC tanks with steel supports, and a self-supporting structure of PVC. The main disadvantage of coated and supported tanks is the danger of corrosion of the supporting structure, even though coated. A self-supporting structure made of PVC was found to be feasible. Cost analysis indicated that the added cost of material in the self-supporting structure was more than offset by the reduced fabrication costs as compared to coated or supported design.

The machine was constructed entirely from commercially available PVC sheet, bar, pipe, molded pipe fittings and standard extrusions. The parts that were made from sheet stock were cut to size and bent to shape using strip heaters. The extrusions were notched and formed around the sheet stock pieces and solvent bonded in place. The ends were fabricated separately, then joined to the central chamber.

In addition to the main structure, PVC was selected for the plumbing, spray nozzles, conveyor and screen filters. The pump, shown in an accompanying photograph, was also constructed of PVC with the exception of a titanium shaft, a TFE seal ring, and titanium studs to hold the housing to the motor.

PVC was also used extensively to protect the electrical system of the machine. The controls are contained in a PVC housing on top of the machine. PVC-covered flexible conduit and molded PVC junction boxes and covers with foam PVC gaskets are used throughout.

New joining technique

Production techniques for joining the PVC extrusions to sheet stock had to be developed. Hot gas welding proved too slow and unreliable unless carefully controlled. Standard solvent bonding, though successful for joining sheet to sheet, was not satisfactory because it did not allow enough assembly time after the solvent cement was placed in the extrusion. Also, unless great care was taken in cutting to proper size, a leaky and weak bond was obtained. Much of the difficulty was due to variations in the thickness of the sheet and variations in the extrusions.

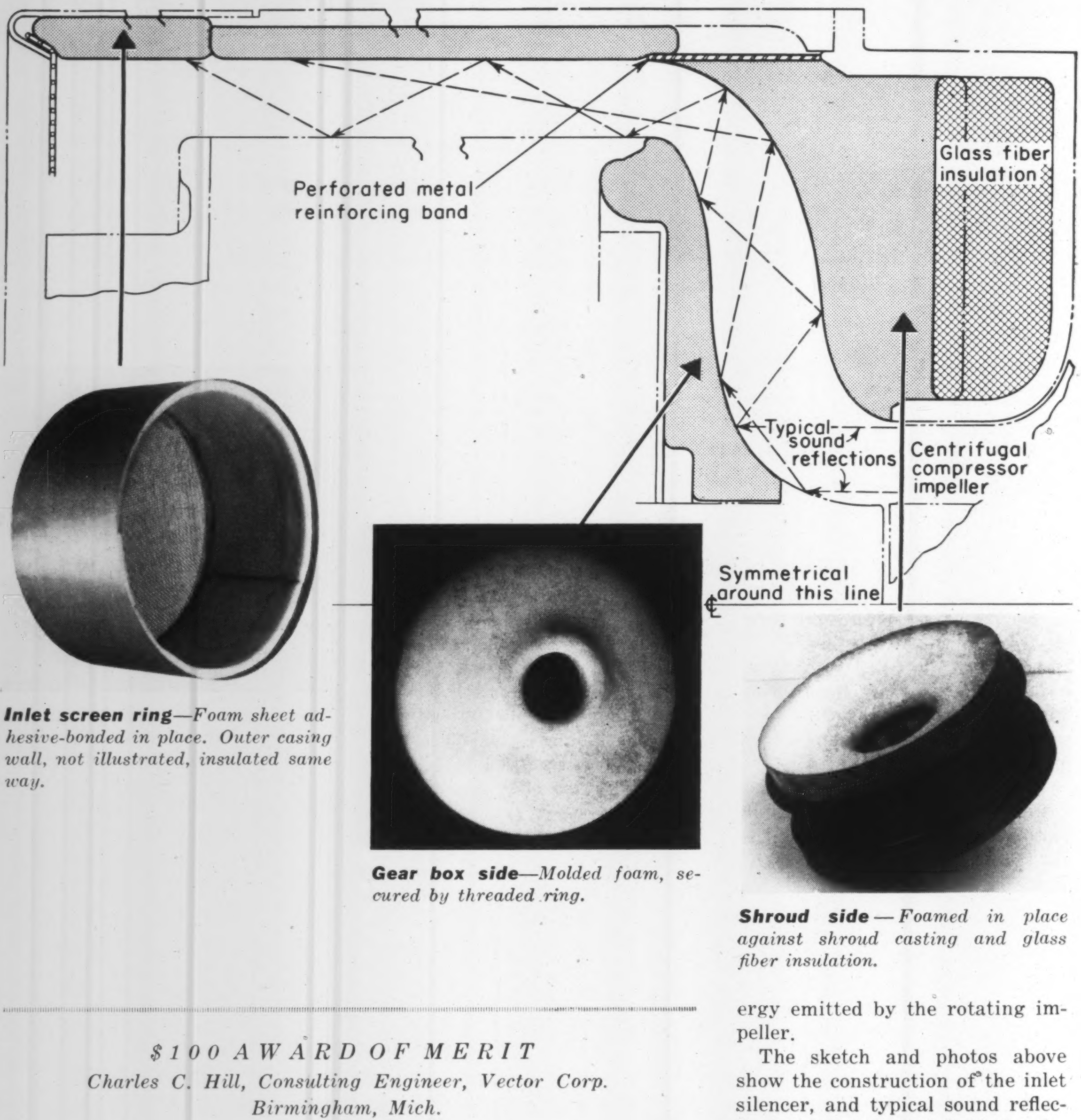
The problem was solved by assembling the parts to be bonded, clamping in place, and injecting the bonding materials into the extrusion under pressure. This new technique, injection solvent bonding, enables the parts to be assembled at leisure and then firmly bonded in place when accurate assembly is assured. An accompanying photograph shows the superior bond obtained with the new process. The joint strength with the new technique is nearly double that obtainable by the standard method.

Centre Circuits, Inc. would like to thank Dr. George Fleming, Dept. of Chemistry, Pennsylvania State University for his suggestions on the use of titanium.

Step 2—Comparing Relative Cost, Available Forms, Fabricability

Step 3—Comparing Strength, Clarity

Relative Cost	Available Forms	Machining Quality	Joining Methods	Compr Str, psi	Ten Str, psi	Clarity
5	Sheet, rod, tube, moldings, extrusions	Very good	Cementing			
0.41	Sheet, rod, tube	Good	Heat weld	1,000	4,000	Translucent
0.30	**Sheet, rod, tube, moldings, extrusions**	**Good**	**Heat weld**	**10,000**	**8,000**	**Translucent opaque**


Perforated metal reinforcing band
Glass fiber insulation
Typical sound reflections
Centrifugal compressor impeller
Symmetrical around this line
℄

Inlet screen ring—*Foam sheet adhesive-bonded in place. Outer casing wall, not illustrated, insulated same way.*

Gear box side—*Molded foam, secured by threaded ring.*

Shroud side—*Foamed in place against shroud casting and glass fiber insulation.*

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Charles C. Hill, Consulting Engineer, Vector Corp.
Birmingham, Mich.

Urethane Foam Cuts Noise, Weight of Gas Turbine Inlet Section

■ Urethane foam provides maximum silencing effect, as well as minimum weight, in the inlet section of a small gas turbine engine. The foam selected by Vector Corp. is a 2 to 6-lb-per-cu-ft flexible polyester-type urethane.

The function of the inlet section is to guide ambient air into the compressor impeller at air flow speeds up to Mach 0.5 (half the speed of sound), and at the same time absorb as much as possible of the high frequency sound energy emitted by the rotating impeller.

The sketch and photos above show the construction of the inlet silencer, and typical sound reflection patterns achieved in the design. Following are the seven major materials requirements for the inlet section—and how the urethane foam meets them.

Seven reasons for urethane

1. *Must permit design freedom sufficient to meet aerodynamic flow needs.* Urethane foam provides a smooth, accurate surface, with no limitation on radii or depth of draw. Only alternate material satisfactory from the functional standpoint would be glass fibers retained by perforated

metal. Such construction would require elaborate multistage tooling to produce sharp radii and deep draws without cracking the sheet metal.

2. *Must resist ablation at air speeds up to Mach 0.5.* Tests in an operating engine proved that the 2 to 6-lb-per-cu-ft foam had the required resilience, as well as enough stiffness to resist erosion and deformation at required air speeds.

3. *Must have good sound absorption at frequencies of 6000 to 15,000 cps.* Sound absorption coefficient of the urethane foam over the frequency range of the compressor is about 0.85-0.90. Foaming the urethane in place against the shroud casting also dampens any "bell ringing" vibrations of the shroud that may occur in response to mechanical and sound pressure.

As can be seen in the sketch, the passage was designed to reflect sound waves as many times as possible, consistent with low air flow pressure losses. The total pressure loss through the inlet is less than 8 in. of water at full air flow.

4. *Must withstand temperatures of 200 F; 350 F in one localized area.* Flexible urethane foams are suitable for service at temperatures up to about 200 F, which is sufficient for most regions of the inlet silencer. Local areas on the shroud casting reach temperatures as high as 350 F. Glass fiber was used to insulate the foam face, setting up a temperature gradient and reducing the temperature at the glass fiber-urethane interface to less than 200 F. Foamed in place, the urethane bonds itself to the aluminum casting and retains the glass fibers securely.

5. *Must be lightweight.* Total weight of foam used in the inlet silencer is 26 oz, which is lighter than any other construction considered.

6. *Must withstand deterioration by lubricating oils and water*—The foam has good resistance to oil and water, and does not absorb excessive moisture from humid air.

7. *Should be simple to install and low in tooling cost*—The shroud side is foamed in place, and by bonding itself to the shroud casting eliminates need for mechanical fastenings. The molded form for the gear box side is retained by a threaded ring (which also serves another function in the power plant). Foam sheeting along the casing wall is contact-cemented in place. Elimination of mechanical fasteners provides both 1) safety, in that it precludes a fastener vibrating loose, passing through the rotating blades and damaging the engine, and 2) economy, in that mechanical fasteners would have to be safety wired, which is time consuming and difficult to inspect.

The tooling is simple and low in cost, consisting of hardwood molds and forms finished with clear lacquer and wax. Plastics duplicate molds can be cast from the wood forms to increase production molding capacity.

Glass-Metal Bond in Optical Device Withstands Liquid Oxygen

■ In designing an optical sensing device to withstand contact with a stream of liquid oxygen, GE arrived at the following point in its study:

1. The lens would be a rectangular glass window mounted inside a metal pipe by adhesive bonding.
2. The glass would be Vycor or Pyrex.

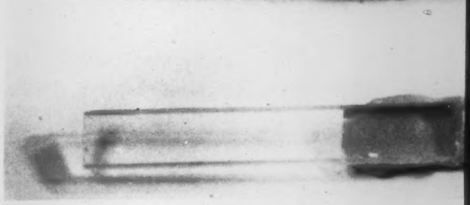
$100 AWARD OF MERIT
A. F. Ringwood and N. Chessin
General Engineering Laboratory
General Electric Co.
Schenectady, N. Y.

3. The metal would be Invar, stainless steel, or one of several aluminum alloys.
4. An adhesive was needed that would a) be compatible with one of the glass-metal combinations, and b) provide a bond to withstand liquid oxygen and meet the necessary strength requirements.

Further investigation indicated that satisfaction of the bond requirements was almost completely independent of the glass-metal combination used. The determining factor was the adhesive system. An epoxy resin primer combined with a polyurethane binder proved most effective.

Narrowing the choice by thermal shock tests

Four adhesives were chosen for compatibility and potential bond



Liquid oxygen exposure *caused spalling of epoxy bond (top), left silicone and polyurethane bonds unaffected.*

RESULTS OF BOND STRENGTH TESTS

Test	Description	Results
Room Temperature	Ordinary handling	Polyurethane samples tough; silicon samples broke easily at bond
Thermal Shock	Dip into liquid nitrogen 20 times, removing for 5-min intervals	No bond failure
Vibration in Liquid Nitrogen	Frequencies of 8-200 cps, displacements yielding 12-g acceleration	No bond failure
Tensile Load under Liquid Nitrogen	Tensile samples bonded over ⅛ sq in. area, loaded at 0.5 in./min	No bond failure; glass failure in all tests ranged from 248 to 1048 psi
Thrust Load under Liquid Nitrogen	Rectangular glass bonded to slot in aluminum frame; thrust applied away from land	Only one failure (due to misalignment); stress ranged from 1106 to 1630 psi

strength: an inorganic cement, a silicone elastomer, an epoxy and a polyurethane. All possible glass-metal combinations were bonded with these adhesives and submerged in liquid oxygen for 20 min. No reactions were observed during the test, but subsequent examination revealed that thermal shock had spalled the epoxy bonds. The inorganic cement bonds did not fail but were too weak at room temperature. The polyurethane bond was good but the adhesive could be peeled away from the glass. Further experiment brought out the fact that a thin prime coat of epoxy resin greatly increased the adhesion of polyurethane, yet did not spall.

Further tests, described below, were made with this epoxy-polyurethane system and also with the silicone adhesive.

Final bond tests

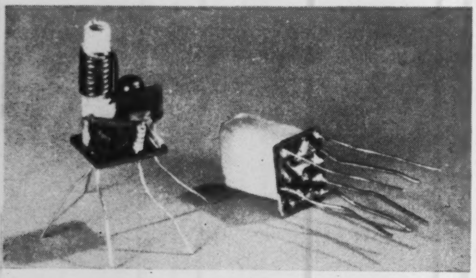
Bond requirements were:

1. Shear strength sufficient to prevent windows from being crushed by the contracting metal of a slightly oversized rabbet.
2. Tensile strength sufficient for the bond to hold under service conditions.
3. Resistance to vibration.

Tests were set up to measure these bond strengths using the two adhesives and all possible metal-glass combinations. Liquid nitrogen was substituted for oxygen for convenience. Results of these tests are summarized in the accompanying table.

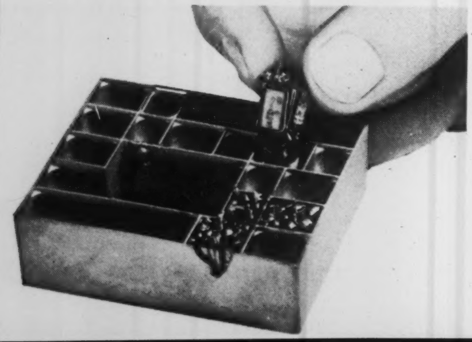
A study of the resultant strength values showed that Pyrex glass bonded to any of the metals with the polyurethane-epoxy adhesive system was the most effective combination. Not only were the low temperature properties sufficient to withstand the applied forces but the room temperature properties were superior to those obtained with the silicone elastomer adhesive.

Thin-Walled Plastics Housing Used in Two-Way Pocket Radio



***Typical cell** supports a printed circuit board.*

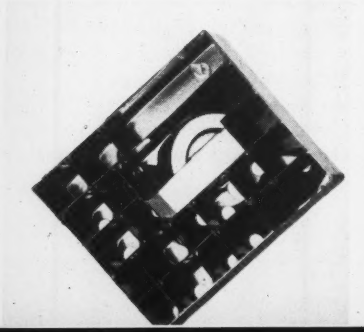
***Modular housing** holds up to 21 cells.*



$100 AWARD OF MERIT

Dominic Errichiello
C&IE Div., Portable Products
Motorola Inc.
Chicago, Ill.

***Plastics housing** is made of a glass-filled polyester resin.*



■ A small glass-polyester housing molded to close dimensional tolerances is an integral part of a new miniaturized two-way pocket radio.

The two-way radio, consisting of a receiver and a transmitter, can be carried in the pocket or worn on the belt to give excellent local two-way coverage.

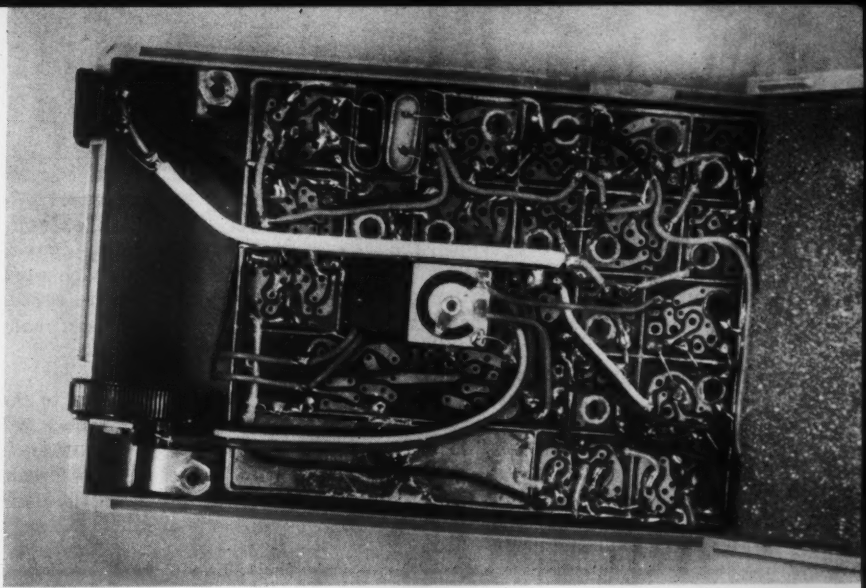
Why glass-polyester?

A glass-filled polyester molding compound (Williamson Adhesives No. 810021) was chosen for the housing because it can be molded to very thin walls—0.020 in. in the case of the housing. Other reasons for choosing the glass-polyester compound include: good molding properties, low moisture absorption and good heat resistance.

The plastics housing, which is

copper plated and given a gold flash to make it solderable, is of modular construction. It provides an effective electrical shield over frequency ranges of 455 kc to 175 mc. The plastics housing supports up to 21 different cells which make up an entire receiver.

Each cell opening in the plastics housing supports an individual printed circuit board. The cell openings are designed with a sharp radius 0.05 in. from the top followed by a shoulder (which supports the circuit board) and larger radius going to the bottom. This design utilizes the maximum available space of each cell opening at the top.



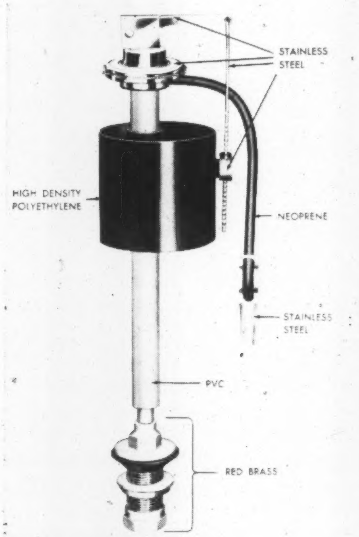
Radio receiver *with full complement of cells.*

Redesigned Toilet Ball Cock Costs Less, Lasts Longer, Works Better

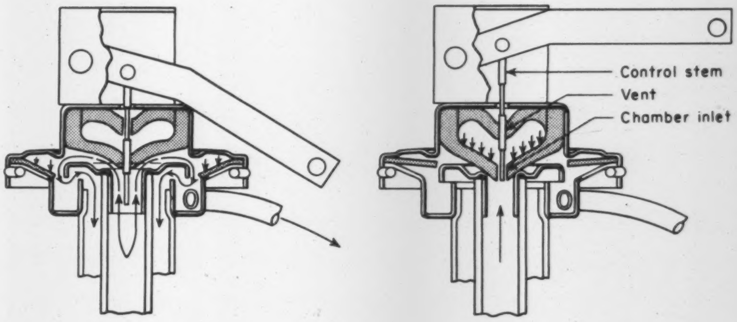
$100 AWARD OF MERIT

Fluidmaster, Inc.

Anaheim, Calif.



Compact unit *uses several different materials to insure most efficient performance.*



POSITIVE SHUTOFF

FULL FLOW

Operation sequence *for positive shutoff and full flow.*

■ By changing the basic design and turning to a different material, Fluidmaster has developed a new toilet ball cock which is said to eliminate many of the disadvantages inherent in conventional units.

The new design: a simplified concentric float (replaces the conventional rod and air-sealed ball); the new material: Grades 301, 302 and 305 stainless steel (replaces brass).

Advantages of the change: instant positive shutoff, quieter operation, automatic anti-siphoning, perfect operation with high or low water pressure, exact water level control, ease of installation, no water waste, complete resistance to corrosion, and reduced maintenance.

Selection of materials

Except for the shank end, attachment nuts and fill tube (which are made of code-specified brass), all metal parts are made of stainless steel. The hush tube (which discharges water into the tank) is made of rigid polyvinyl chloride; the refill tube is made of neoprene; and the concentric float is made of high density polyethylene.

The brass parts were replaced because they corroded very rapidly; stainless was selected primarily because it provides the desired corrosion resistance at minimum cost. In addition, it offers scratch and abrasion resistance, ease of fabrication, light weight, better appearance, reduced maintenance and greater flexibility of design.

The air-sealed ball was replaced because it developed leaks; high density polyethylene was selected because it is extremely durable and easy to mold.

Polyvinyl chloride was selected for the hush tube because it is resistant to attack from water in any part of the United States.

The basic design was changed because it was inefficient; caused squeaks, whistles, etc.; and made repairs difficult and costly.

How unit works

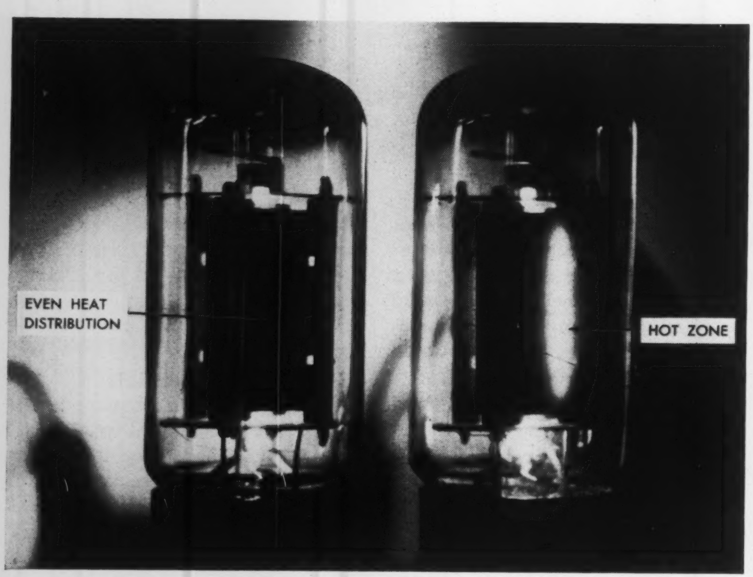
The concentric float, key to the unit's operation, contains two chambers: the upper chamber is filled with water; the lower contains trapped air. As the float moves up or down, it moves a small control stem in and out of a hole in the top and bottom of a rubber heart-shaped chamber (see drawings).

When the float rises to the point where the control stem opens the hole in the bottom of the heart-shaped chamber, water enters the chamber and "inflates" it against the inlet opening, thus closing off the water supply to the tank. When the float drops down, the top hole in the chamber opens to release the trapped water, the chamber deflates, and water flows freely to fill the tank.

Copper-Base Anodes Reduce Tube Power Input by 40%

$100 AWARD OF MERIT

*W. T. Millis and J. F. Stephens, Receiving Tube Dept.,
General Electric Co., Owensboro, Ky.*



Heat distribution *is uniform in copper core anode of 6L6G6 tube (left); carbonized-nickel-clad steel anode of 6L6GB tube (right) shows hot zone.*

■ High temperature problems created by tube miniaturization and higher dissipation ratings have been successfully solved by switching to anodes made either of layers of aluminum and steel over a copper core, or of aluminum and steel over a copper base. Advantages gained through the use of the new copper-base anodes are:

1. Increased thermal conductivity.
2. More effective heat radiation.
3. Lower temperature at a given level of plate dissipation or, conversely, higher plate dissipation at a given temperature.
4. Higher thermal efficiencies, resulting in a reduction in tube power inputs by as much as 40%.

Why the change?

Because of its configuration an anode seldom operates at a uniform temperature and is inclined to develop hot zones. These hot zones tend to increase gas evolution from the anode, as well as increase the temperature of other tube elements such as the grids, cathodes and envelope.

Temperatures have become so high as to seriously effect tube reliability and life. In order to reduce anode hot spot temperatures it has been common practice to use materials with good thermal radiation properties in conjunction with radiating fins. Materials such as carbonized-nickel-clad steel and a low carbon steel clad on either side with nickel and aluminum have been extensively used for this purpose. However, the thermal conductivity of these materials is limited, and the amount of radiation that they can provide is governed by tube geometry. Their thermal conduction can be raised by increasing thickness but the resulting increases in mass, complexity and cost are undesirable.

Copper-base anodes best for rectifier tubes

Two of the biggest problems in designing rectifier tubes are the high heat concentrations produced at the anode, and the effect some anode materials (not copper) have on cathode emission. Ordinarily, these problems have best been overcome by using an anode made of a low carbon steel core clad with a shiny nickel layer on the side that faces the cathode, and an aluminum layer on the reverse side. However, vastly improved performance is now obtained by using an anode made of aluminum-clad steel on a copper base. The shiny copper base faces the tube cathode.

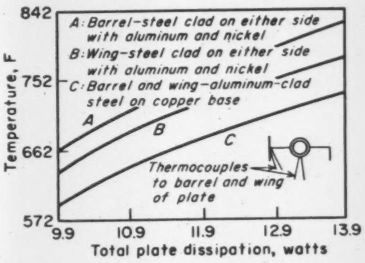


Fig 1—*Temperature advantage of aluminum-clad steel on copper base as compared to steel clad on either side with aluminum and nickel. (All parts 0.007 in. thick.)*

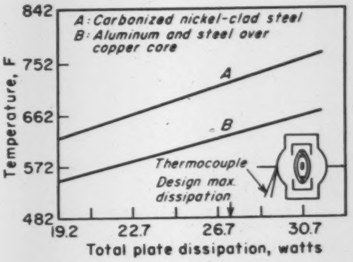
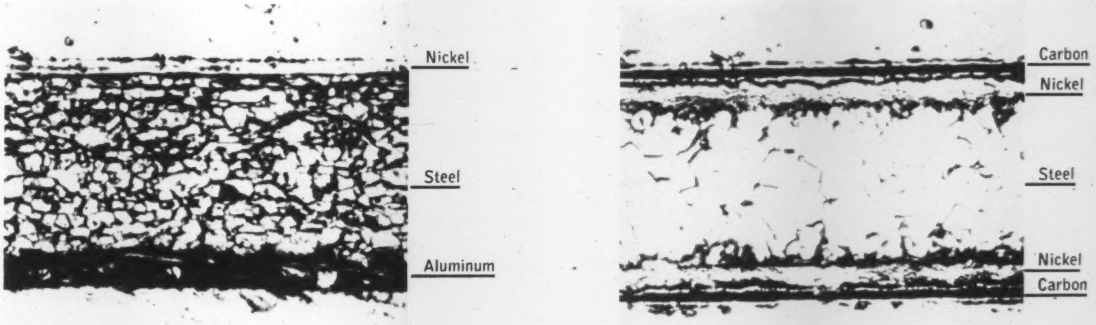


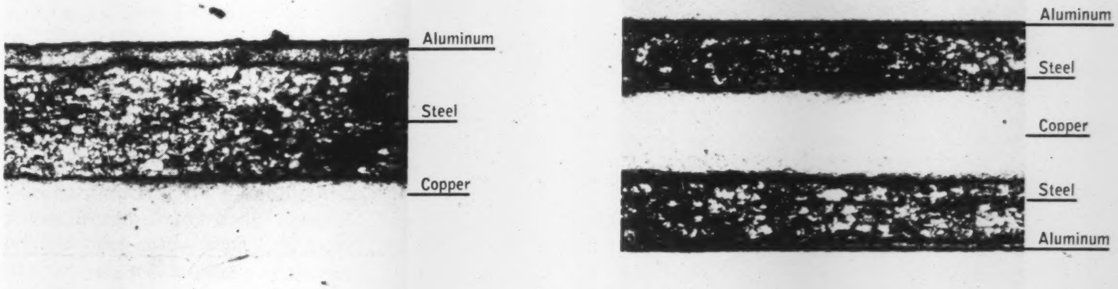
Fig 2—*Temperature advantage of copper core anode as compared to carbonized nickel-clad steel. (All parts 0.007 in. thick.)*

A comparison of operating temperatures of the old and new anodes shows a significant advantage in favor of the aluminum-clad steel on a copper base (see Fig 1). Other comparative tests show that the copper-base anode produces high cathode temperatures for a given amount of

Anodes before redesign



Anodes after redesign



heater power; permits the cathode to heat up more rapidly; and provides greater effective cathode emissive area than a nickel-steel-aluminum anode for a given amount of heater power.

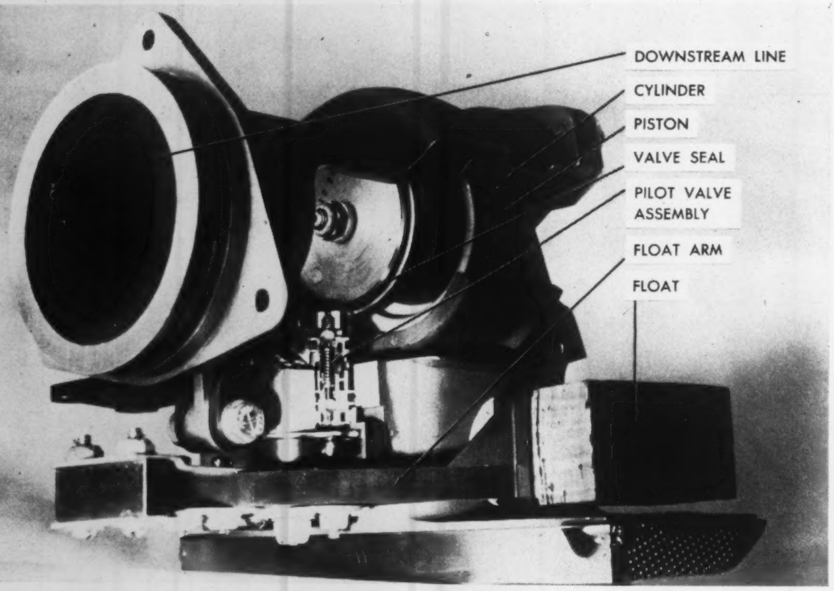
Two types of rectifier tubes using copper-base anodes have recently been placed in production. One type (6AF3) is a half-wave, close-spaced cathode type intended for use as the damper tube in horizontal sweep circuits of television receivers. The other (5AR4) is a full-wave rectifier intended for low voltage power supplies. The 5AR4 tube is essentially two sections of the 6AF3 tube placed in the same envelope.

Copper core anodes best for amplifier tubes

In general, the thermal radiation and conductivity properties of copper core anodes are essentially the same as for copper base anodes. However, because of its configuration the copper core material has proved best suited for amplifier tubes, as in the case of the newly-developed 6L6GC. This tube is a redesign of the 6L6GB which uses a carburized-nickel-clad steel anode. Use of the copper core anode in the 6L6GC allows an increase of 8 w in plate rating over the 6L6GB, or a 40% increase in dissipation with a higher temperature safety factor. As expected, the copper core anode produces longer tube life.

A dramatic illustration of the temperature difference between a copper core anode and a carburized nickel clad steel anode in a 6L6 tube is shown in the photograph above. At the same dissipating wattage, the copper core anode exhibits uniform heat distribution, whereas the carburized nickel anode shows a high temperature zone. A graphical representation of the temperature characteristics of the two materials is shown in Fig 2.

Ceramic, Nylon, New Rubber Needed for Jet Fuel Valve



Fuel shut-off valve—*In this view cylinder is cut away showing piston.*

$100 AWARD OF MERIT

R. E. Forrester, Project Engineer, Aero Supply Mfg. Co., Inc.
Corry, Pa.

■ Three engineering materials solved four critical design problems in the successful development of a jet aircraft fuel shut-off valve. The purpose of the valve is to prevent air from entering the fuel lines, either when the fuel tank runs dry or when the aircraft is executing an extreme maneuver.

Operational requirements

The valve is a differential-pressure-operated valve, which is not new; however, the severe requirements of operation in supersonic aircraft are new, and preclude the use of many of the materials previously used for similar valves.

Operational requirements that affected materials selection include:

1. Must operate submerged in jet fuel at temperatures of –65 to 185 F.
2. Must operate wet with fuel through ambient temperatures of –65 to 250 F.
3. Must function satisfactorily while vibrating in accordance with Fig 1 of MIL-E-5272 (0.036-in. double amplitude from 10 to 75 cps and 10 g's continuous vibration from 75 to 500 cps, applied in three planes).
4. Must operate reliably in fuel contaminated with a mixture of Arizona road dust, sharp silica sand, and lint fibers.

Actuator piston—steatite

The actuator piston, as shown

in the cutaway view, opens and closes the main valve. When the fuel level drops sufficiently to lower the floats, the float arm closes the pilot valve. When the pilot valve closes, it shuts off a bleed line, thus building up pressure behind the piston to close the main valve.

When the fuel level is high enough to submerge the floats, the float arm opens the pilot valve in the bleed line, reducing pressure behind the piston. The fuel pressure in the main cylinder downstream of the piston forces the piston back, opening the main valve.

Piston requirements—Materials requirements include: 1) accuracy, to permit free sliding, yet minimize leakage, 2) corrosion and erosion resistance, 3) hard surface, non-galling after long periods of inoperation, 4) dimensional stability over an extreme temperature range; cylinder and piston materials must have similar coefficients of thermal expansion, 5) strength to contain operating pressures inside piston chamber, 6) light weight, 7) durability to withstand handling during manufacture and maintenance.

Materials selection — Steatite was finally selected after rejecting four materials: 1) series 400 stainless steel—too heavy, 2) hard surfaced aluminum—precision machining reduced hard surface to thin veneer over soft base, 3) carbon—eroded rapidly, and 4) alumina—heavier and more expensive than steatite.

Steatite has a Mohs hardness of 7 and can be ground with diamond tools after firing. Diametral clearance between piston and cylinder is held to 0.001 in. max and 0.0004 in. min. Leakage is held in the range of 20-30 cu cm of fuel per min at 60 psi pressure. Leakage decreased after 100,000 cycles test in contaminated fuel.

Main valve seal—fluoro-silicone rubber

The severe temperature and chemical resistance requirements preclude the use of a conventional elastomer for the main valve seal. Much effort was devoted to designing a metal-metal seal, but air leakage could not be controlled.

The recent development of fluoro-silicone rubber occurred just in time for this application. The elastomer's resistance to fluids and temperature extremes are sufficient for long reliable life. Design of the proper method for clamping the seal to the valve face required careful attention to circumvent the material's low tear strength. A second fluoro-silicone rubber seal is used around the o.d. of the cylinder to provide a seal which will not load the cylinder excessively in compression.

Float arm—nylon

In designing the float arm, sheet metal construction was considered. Though light in weight, such construction would have to be intricate because of space limitations, and would provide no vibration damping.

An investment casting would have been lightweight and simple, but mold costs would have been about $1,400 and each casting would have cost $6.

Nylon was selected as providing the required strength, as well as vibration damping. The nylon molding incorporates all contours and attaching holes which otherwise would require machining. The part is produced in a mold costing $1,200 and is purchased in finished form for 53¢.

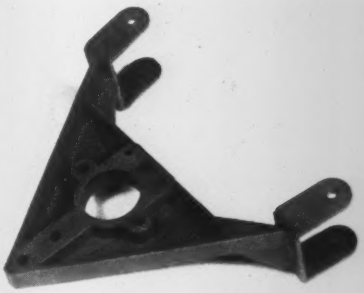
Mounting brackets—nylon

The valve is mounted adjacent to the inside bottom surface of the wing tank and is attached to structural brackets by four mounting screws.

As the valve was originally mounted, using metal brackets, it was found that when vibrated dry (i.e., tank empty) resonance occurred between the flat plates forming the lower surface of the valve and the float arm assembly. At various frequencies the resonance became violent enough to momentarily open the valve, allowing discharge of a slug of air. Vibration-absorbing mounts could not be used because of space and weight limitations.

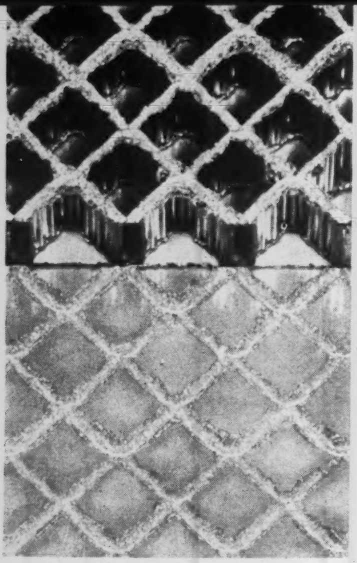
Nylon mounting brackets identical in configuration to the metal ones reduce the natural frequency of the entire installation by introducing just enough flexibility to damp out vibration transmitted through the mounting brackets. Consequently, over the entire vibration frequency range, in all three planes, and at temperatures of -65 to 250 F, the floats now remain absolutely still, eliminating all undesirable valve opening.

Steatite cylinder *(piston inside) showing fluoro-silicone rubber seal on valve face.*



Nylon float arm, *to which two floats are assembled.*

Nylon mounting brackets *attach valve to fuel tank.*



Honeycomb *with face sheet removed to show structure.*

All-Welded Honeycomb Reduces Cost, Improves Performance

$100 AWARD OF MERIT

John J. Foster Mfg. Co.
Costa Mesa, Calif.

■ A honeycomb sandwich, called "Stresskin," is formed by resistance welding face sheets to a flanged core. The core is welded at the nodes and produced from corrugated strips having flanges on opposite edges.

The construction permits fast, continuous, economical operation on all high temperature materials. Size is limited only by available size of face sheets. In-process inspection minimizes inspection costs and improves reliability. The construction offers the only possibility of using cold worked precipitation hardenable steels in face sheets and yields highest available strength-weight ratios. — *Details will be published in the June issue.*

New Ferrites Boost Computer Speeds

$50 CITATION

Barlane R. Eichbaum
Staff Ceramist, International Business Machines Corp.
Poughkeepsie, N. Y.

■ Desiring to substantially increase the speed of a new high speed computer, IBM found that no existing ferromagnetic material would meet the requirements of the proposed memory system.

MAGNETIC PARAMETERS OF NEW FERRITES

Type ➡	DM-1	DM-2
Composition, mole %	20 CdO, 40 MnO, 40 Fe_2O_3	20 CdO, 35 MnO, 45 Fe_2O_3
Pulse Characteristics		
Undisturbed One (uV_1), mv	1000	1000
Undisturbed Zero (uV_z), mv	200	200
Switching Time (T_s), μsec	90	90
Coercive Force (H_c), oe[a]	0.15	0.22
Curie Temp (T_c), F	194	203
Switching Constant (S_w), oe-μsec	0.22	0.20
Saturation Flux Density (B_s), g	1500	—

[a] Tested with a field of 2.55 oe.

As a result of an extensive development study, a new high speed square loop material was developed to provide a memory element with a read-write cycle time of 0.5 μsec, as compared with 8 μsec for typical present high speed computers.

Switching speed of the new memory core is 0.1 μsec, with a half-select current of 1 amp-turn or less and a 50 ms rise time. In comparison, switching speeds on existing cores are 1.2 to 1.5 μsec, with half-select currents of about 0.4 amp. The one-to-zero ratio of the new element is greater than 3:1.

New ferrites

Extensive screening narrowed the study down to the cadmium-manganese ferrites (CdO•MnO•Fe_2O_3). Although the MnO-to-Fe_2O_3 ratio alters magnetic characteristics, variation of the CdO content has a much greater effect on such changes. After thorough testing, two compositions were found to meet the desired requirements. Both types have 20 mole percent CdO; lower CdO-content materials have greater squareness and a slightly slower switching time. Characteristics of the two ferrite materials, designated DM-1 and DM-2, are shown in the accompanying table.

Protective Helmet Redesigned to Cost Less, Weigh Less

$50 CITATION

Louis Gwinn, Fred Zant
and Herman P. Roth
United Tanks, Inc.
Inglewood, Calif.

New *police safety helmet has integrally molded shell and visor, and one-piece foam liner.*

■ The success of protective helmets for motorcycle patrolmen has led to increasing demand for similar helmets for general-duty officers in cars or on foot. Although energy-absorption requirements are not as severe for such helmets, they must be lighter in weight for head comfort, and lower in cost for wide acceptance.

By making use of new plastics processing techniques and improved materials, United Tanks successfully designed such a helmet. In comparison with the motorcycle helmet, the new helmet 1) weighs 16-18 oz, vs 22-24 oz, and 2) costs $19.75, vs $29.75. The new helmet provides protection against impacts of up to 60 ft-lb (current test standard for AF and Navy crash helmets) vs 100-120 ft-lb for the motorcycle helmet.

Essentially, the helmet consists of a high strength-to-weight ratio, glass-reinforced polyester shell lined with an energy-absorbing cushion of polystyrene foam. The helmet is supported by an inner adjustable harness.

Reinforced plastic shell

Old—The shell was formerly fabricated of glass mat and polyester resin in matched metal molds. The high gloss, white finish required over most of the shell exterior necessitated a series of filling, priming and finishing operations to conceal surface irregularities inherent in high glass-content, mat-preform-molded shells.

New—In redesigning, the visor (previously attached after the helmet was produced) was integrally molded, and the new technique of simultaneously spraying chopped glass and resin was used to form the shell. The process, developed by Chemold Co., provides a finished shell with integral, glossy white surface, and improved resistance to scratching and marring.

Steps in the production process include: 1) spray-molding a female mold, working from a highly finished male master, 2) after cure, giving the female mold a high polish, and 3) spraying a white gel coat in the female mold, followed by spraying chopped glass and resin to form the shell wall proper. Experimental work on this technique was carried out by Fiber-Resin Corp. Using the Twin-Tip spray gun and Glass Hog manufactured by Peterson Products. Uniformity of wall thickness and control of total shell weight is dependent on the operator's skill, but have been found to be satisfactory after reasonably short experience.

The resin used in the redesigned helmet is a new, high viscosity isophthalic polyester, developed by Fiber-Resin for use with the gun. Superior wetting properties provide exceptionally high physical properties. Glass content of the shell is about 50%.

Foam liner

Old—The original motorcycle helmet liner was made from prefoamed polystyrene sheet, ½ in. thick. Two pieces were postformed to the configuration of the shell.

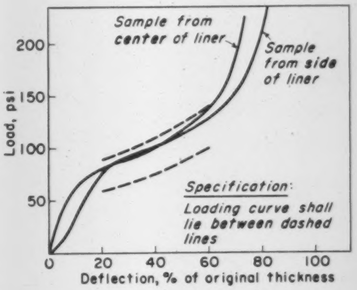
New—The new liner is molded in one piece from expandable polystyrene beads by Zant & Asso. Processing variables and density of the foam are controlled to provide crushing strength within the range tolerable to the human head, yet as high as possible within this range to provide maximum energy absorption during impact compression. The graph shows a typical load-compression curve for a test sample taken from a liner, and the load-compression limits within which the material must fall.

Since the as-molded inner surface of the liner is not soil-resistant, the interior surface and exposed edges are sprayed with a gray epoxy resin to provide an easy-to-clean surface. The coating, produced by Lockrey-Fater, provides a smooth surface, yet will not attack the polystyrene foam.

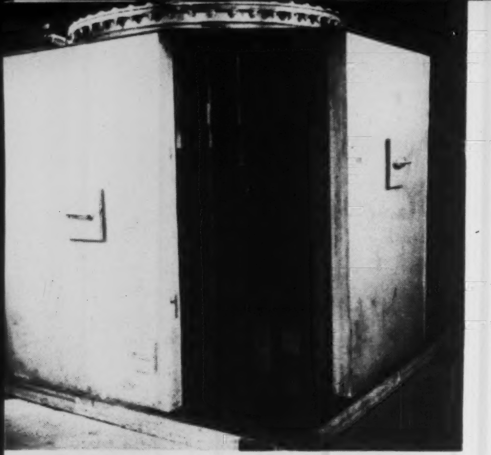
Other features

Both cost and weight reduction were also accomplished by replacing the flexible polished metal "snake strap" trim on the old helmet with a strip of embossed metallized Mylar formed over an adhesive-faced, flexible plastics strip.

The suspension system has also been redesigned and improved, making use of polyethylene, textured vinyl sheet and soft urethane foam firmly anchored to the foam liner.



Compression-deflection curves, *showing typical characteristics of foam samples taken from center and from side of liner.*



Neutron reflector *of composition hardboard surrounds graphite region of small nuclear reactor.*

Composition Hardboard Reduces Cost of Small Nuclear Reactor

$50 CITATION

Anthony Stathoplos
Nuclear Development Corp. of America
White Plains, N. Y.

■ Composition hardboard, because of its low cost, was selected over graphite, heavy water and beryllium metal as a reflector material in a small nuclear reactor specifically designed for teaching and research. In this application, composition hardboard costs $1.10 per sq ft compared to $38, $600 and $3000 per sq ft for graphite, heavy water and beryllium metal respectively.

Wood planking was considered as a reflector material, but it is less homogeneous than hardboard and is susceptible to warping and shrinking. Regular water was also considered, but it requires a container that is difficult to erect and modify.

Other advantages

The composition hardboard, in addition to low cost, has good nuclear properties, is readily available, has good resistance to the moisture and heat usually encountered in small reactors, and is easy to fabricate. Reflectors made of the material are easy to assemble and fasten, can be readily modified in the field, and are structurally self-supporting.

The reflector consists of a 4-in. thick layer of composition hardboard that is made by laminating five ¾-in. thick sheets together with a commercial glue. A ¾-in. thick sheet has an average weight of 3.12 lb per sq ft, a tensile strength of 2000 psi, and a modulus of rupture of 4200 psi.

Composition hardboard reflectors maintain a high neutron density (flux) inside the region they surround, are relatively free of impurities that absorb neutrons, and have a high reflection factor (large scattering cross section).

Reactor construction

The small nuclear reactor consists of a core located in an aluminum tank containing heavy water, which acts as moderator and core coolant. Surrounding the tank is a 1-ft thick layer of graphite which comprises the experiment region. Surrounding the graphite region is the 4-in. thick layer of composition hardboard which maintains proper neutron density in the graphite region and prevents excessive neutron leakage from the system.

Metal Fibers Improve Performance of High Temperature Filters

Filter unit *formed from metal fibers.*

$50 CITATION

Morris Kibrick, Metallurgist
Purolator Products, Inc.
Rahway, N. J.

■ Use of metal fibers instead of metal powders in a metallic filter medium has increased permeability, provided greater flexibility and improved appearance. The filter medium, designed for relatively low flow with high solids concentration, separates 10 μ particles from corrosive solutions at temperatures up to 1000 F.

Originally this medium was produced from type 430 stainless steel powder. The unit proved to be brittle and was easily damaged. It did not resist corrosion in 10% potassium hydroxide solution at 250 F.

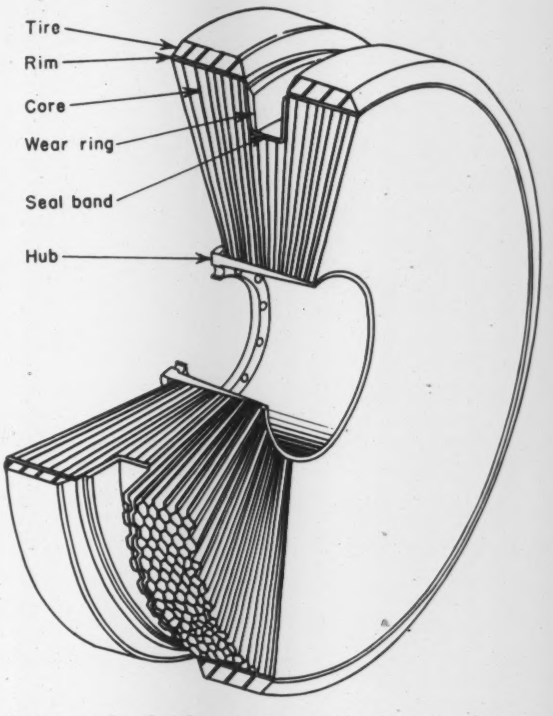
The new unit is produced from type 430 stainless steel fibers. As a result of the change:

1. Permeability was increased, with resulting lower pressure drop under specified flow conditions.
2. Flexibility was increased, making it possible to roll a seal around the periphery without difficulty.
3. Resistance to the environment was improved.

All-Bonded Honeycomb Wheel Has High Strength-Weight Ratio

$50 CITATION

Edward J. Caffney, Professional Engineer
Neodyne Corp., Waukesha, Wis.



Honeycomb wheel *uses 22-gage aluminum laminations to form honeycomb core; all joints are adhesive bonded.*

■ Adhesive bonded aluminum stampings have been used by Neodyne Corp. to fabricate an extremely lightweight wheel which has high strength and shock absorbing properties.

The U. S. Army Ordnance Dept. specified wheels 32 in. in dia to carry normal loads of 8000 lb and, because the wheels were for track laying vehicles, to carry normal side loads of 3200 lb and absorb 10 g loads in any climate. The target weight was set at one-half that of the equivalent steel wheel in service at the time.

The new design—and its advantages

The final design consists of 38 radially corrugated disks of 22-gage aluminum adhesively bonded into a honeycomb core. The core is bonded to the rim and wheel hub to form an integral dual wheel on which solid rubber tires are vulcanized. There are no joints fastened by any method but adhesive bonding. Advantages of the design are:

1. Meets strength requirements with reduced weight of approximately 60%.
2. Space and weight requirements dictated that the width of the wheel decrease from rim to hub. This was automatically accomplished because the corrugations become narrower as the disk diameter is reduced and the core density is thus increased.
3. The one-piece dual wheel construction provides greater beam strength for carrying side loads and makes the wheel easy to handle on the ground.
4. Hardened steel wear rings take the wear caused by rubbing the track guide and were also designed with sufficient strength to disperse the side load over a larger area of the honeycomb core. The side-load strength was also increased by stacking the first few layers of laminations like cake pans. Remaining laminations are stacked alternately to form the honeycomb pattern.
5. A conical disk bonded to the sides of the wheel protects the thinner laminations from brush and stone damage, prevents dirt and mud from accumulating in the corrugations, and improves the beam strength of the wheel for side loads.

Selecting the materials

Choice of a honeycomb structure was dictated early by the requirements of strength-weight ratio. Methods of fastening both laminations and parts were considered next. Welding was eliminated because the labor involved would result in high assembly cost. Salt bath brazing of the aluminum laminations would have been economical. However, the number of sealed-off voids which occur in the honeycomb make it impossible to clean the core properly, and severe corrosion would have resulted. The success of adhesive bonding applied to aircraft honeycomb structures as well as its relative ease of use made this method the final choice.

Aluminum was selected for all honeycomb structural parts for three reasons: 1) its compatibility with available adhesives, 2) its relatively high strength-weight ratio, and 3) its ability to be readily formed. The particular alloy 5052-O was chosen for the core laminations because it has a high elongation which enables the laminations to be pressed out in a single operation without successive drawing and annealing operations. In the final study the same alloy was specified for the cover disk and rim. Screw jacks, which allow loosening of wheel hubs, are fabricated from aluminum casting alloy 355 in order to cut costs.

Wear rings bonded to the vertical portions of the rim sections are of steel alloy 4140 oil quenched from 1550 F and tempered at 1070 F to 320 Bhn. This alloy was specified because of its ability to be heat treated as desired, and because of its strength, toughness and corrosion resistance.

Selecting the adhesive

Narmco Metlbond 302 adhesive tape, a fiberglass cloth-supported phenolic-epoxy, was specified for bonding all parts of the honeycomb wheel. Flat surfaces were bonded with 0.010–0.012-in. tape and the core was bonded to rim and hub with 0.020-in. tape in order to form substantial fillets.

Advantages of the tape form are mainly ease of handling, less waste and moderate bonding pressures. The phenolic-epoxy adhesive proved to have good strength over the expected temperature range, a curing range (300-350 F) which allowed simultaneous vulcanizing of the tire, and good resistance to water and fuels.

CFE Coating Reduces Cost, Extends Life of 'Copter Blades

Wooden *helicopter blades are most efficient.*

$50 CITATION

George R. Stack, Rotors Group Engineer, Doman Helicopters Inc.

Danbury, Conn.

■ A major problem in the design of wooden rotor blades for helicopters appears to be solved. The problem: to prevent instability caused by the changing moisture content of the blade. The solution: use of an extruded CFE (trifluorochloroethylene) film covering (patent applied for).

Wooden blades—and the covering problem

Wooden rotor blades have been used since the helicopter was developed because they are low in cost, have high fatigue life and can be given a smooth aerodynamic finish. However, the lack of adequate protection against moisture, temperature changes, etc., has forced many manufacturers to switch to metal despite the short fatigue life, higher costs and greater horsepower requirements.

Up to now, the two most widely used coverings for the wood blades were various paints and glass cloth-reinforced plastics. The glass-reinforced plastic had these disadvantages: 1) excessive moisture absorption, 2) nonuniformity of resin content from blade to blade, 3) rough airfoil surfaces, 4) loss of strength with increasing temperature, 5) variations in coefficient of thermal expansion, 6) sensitivity to fatigue loading, 7) inadequate resistance to chemical attack, 8) difficulty in repairing the fabric, and 9) a tendency toward delamination.

Paints have not been very successful either because the finish sometimes lasted only a few hours, and refinishing costs are quite high.

Why CFE?

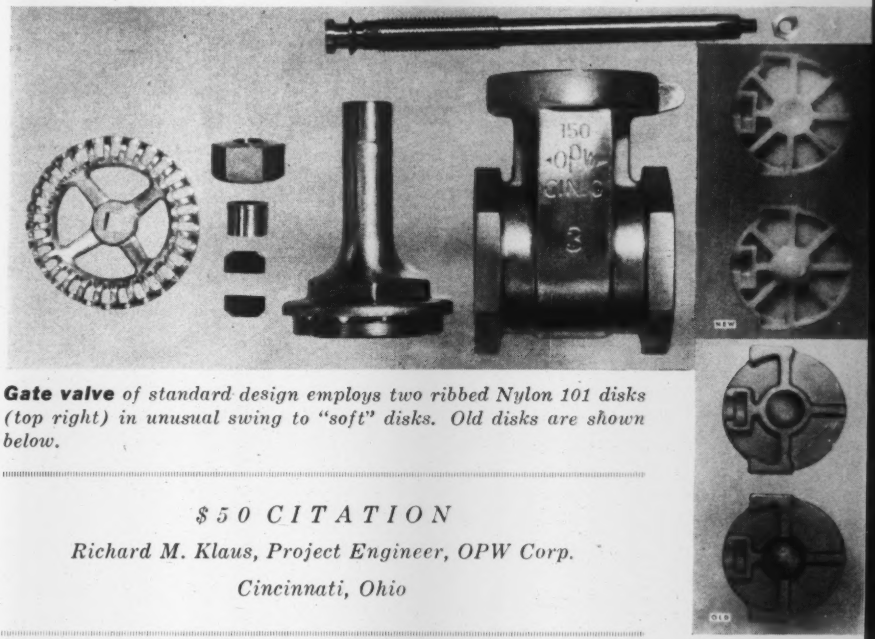
In addition to extruded CFE, several other materials were tested: neoprene, nylon, acrylic, aluminized polyester film, and various CFE laminates (with glass cloth, Orlon cloth and asbestos).

Extruded CFE (Kel-F) film 5-7 mils thick was selected for the blade covering because a series of exhaustive rain erosion and other tests indicated that it was the only material that satisfied all of the following requirements: 1) no moisture absorption, 2) no moisture vapor transmission, 3) uniform thickness and strength, 4) smooth airfoil surface, 5) nonwetting surface, 6) good plastic memory, 7) easily heat sealed, 8) excellent chemical resistance, 9) high impact strength at high and low temperatures, 10) low cold flow characteristics, 11) low modulus of elasticity, 12) resistance to a wide range of temperatures (-320 F to 390 F), 13) colorability, 14) excellent dimensional stability, 15) excellent outdoor aging characteristics, 16) excellent abrasion resistance, and 17) resistance to sunlight.

Costs will be lower

Although the cost of CFE is relatively high as compared to paint or glass-reinforced resin, use of this film in rotor blade production should result in great savings over a period of time for the following reasons: the blades require considerably less time to fabricate; they do not have to be overhauled as often (they last up to three times longer than blades covered with glass-reinforced plastic and up to 20 times longer than blades covered with paint); and they do not become unbalanced and therefore eliminate the time-consuming and costly job of readjustment. The cost of a metal blade is about three times that of a CFE-covered wooden blade.

Soft Nylon Disks Make Possible Lighter, Less Costly Gate Valve



Gate valve *of standard design employs two ribbed Nylon 101 disks (top right) in unusual swing to "soft" disks. Old disks are shown below.*

$50 CITATION

Richard M. Klaus, Project Engineer, OPW Corp.

Cincinnati, Ohio

■ Minimum requirements for any valve—gate, plug or globe type—include low pressure drop and tight shut-off with satisfactory throttling action. A change of the material used in one part—the valve disk—enabled OPW Corp. to produce a general-purpose gate valve to satisfy these requirements and, in addition, to reduce weight and cost. The particular valve illustrated has been used on trucks delivering petroleum products and has resulted in an initial cost saving of $11 and a weight saving of 12 lb per valve.

Designing the valve

The globe type of valve was rejected early because of the excessive pressure drop. The plug type of valve offers advantages of simple construction and easy operation, but the need for lubrication is a major drawback. Study showed that grease mixed undesirably with the fluid. When contamination was acceptable, the grease was invariably soluble in the fluid and maintenance became an important factor. Another approach — using a plastic liner — was discarded because the large area subjected to total pressure resulted in high wear and again increased maintenance cost.

The gate type of valve offers the lowest pressure drop and the shortest length in the direction of flow. The big drawback is the high maintenance cost necessary to maintain tight shut-off against an eroding liquid. But study of all valve types led to the conclusion that the standard gate valve offered the best potential and that the solution of the shut-off problem might lie in the choice of a suitable material for the valve disk—the element that suffers the greatest erosion.

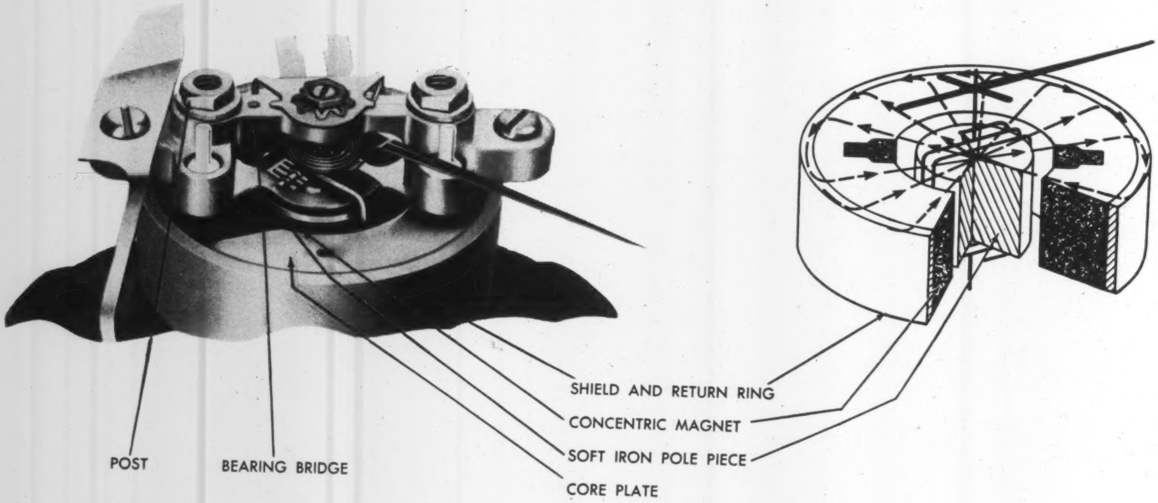
It was found that hard disk materials reduced wear at the expense of added weight and cost. Plastics were then investigated on the theory that their resiliency would render them less susceptible to erosion.

A ball and socket double-disk design allowed the disks to adjust to the surface angles. The relatively small area of sealing contact meant that a low force was sufficient to develop tight sealing. Use of the soft material also had the advantage of requiring only a slight increase in pressure on the disk to press it in against scratches caused by dirt.

Selecting the plastic

Many plastics were considered and tested. Phenolics and epoxies proved too hard for the desired effect. Polystyrene proved inadequate for the chemical resistance required. TFE (polytetrafluoroethylene) was deemed too expensive for the application. The final choice narrowed to nylon and polyvinyl chloride.

The polyvinyl chloride exhibited better chemical resistance and was less expensive. But Nylon 101, with its superior strength properties and moldability, became the final choice. The disks were designed with eight ribs to develop the necessary rigidity and still maintain flexibility. The use of nylon disks also allowed dispensing with the usual hard seat rings because the lubrication qualities inherent in nylon prevented galling of the aluminum body.



Permanent magnet *moving coil measuring device.*

Molded Magnets Simplify, Improve Electrical Measuring Devices

$50 CITATION

Henry Otzmann, Jr., Section Manager
Instrument Engineering, Meter Dept.
Westinghouse Electric Corp., Newark, N. J.

■ Molded magnets — consisting of finely dispersed Alnico particles in a resin binder — are self-shielding and can be molded to close tolerances. Use of such magnets simplifies production and improves performance and stability of permanent magnet moving coil devices such as ammeters and voltmeters.

Production costs cut

Reductions in production costs

are caused by the simplification of design and the self-aligning characteristics resulting from the use of the molded magnet. Previously used high coercive, high energy magnets were formed by casting or sintering, and had to be machined to required tolerances. Also, slight nonhomogeneity in such magnets required the use of soft iron pole pieces to assure uniformity of flux distribution in the air gaps of the device.

Die-molded magnets require no subsequent machining and are homogeneous enough so that no pole pieces are needed.

In the new design, the concentric magnet is used as the basic structural member, locating and aligning all other components. The core is accurately located concentric with the magnet by a close-tolerance core-plate stamping. The stamping is located accurately by a shoulder of the return path ring, which extends beyond the thickness of the magnet. The notches in the magnet magnetically isolate the two sections of the magnet, and also provide for accurate angular location of two posts. These posts are radially positioned by passing through two holes in the core plate stamping. The posts, thus positioned, pass through the bearing bridge, holding the moving element of the device in close alignment in the air gap. Thus, the entire mechanism is accurately self-aligned merely by assembling and tightening.

Improved performance

Absence of soft iron pole pieces permits "pattern magnetizing" to obtain uniform scale distribution. The device can be consistently pattern-magnetized to produce distributions other than linear when desired. For example, increases in sensitivity of as much as 40% at the mid-point of the reading scale have been obtained.

The close tolerances obtainable in molded magnets permit highly accurate positioning of the magnet on the magnetizing fixture. This feature provides a high degree of consistency in pattern magnetizing, when magnetizing on a production scale. The uniformity of results obtainable is also important in calibrating.

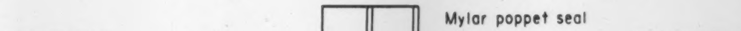
Fluorocarbon, Polyester Seals Increase Reliability of 10,000-Psi Helium Valve

$50 CITATION
Engineering Dept.
Precision Equipment Co., Inc.
Torrance, Calif.

■ Severe pressure and temperature requirements are successfully met in a unique shut-off valve by using fluorocarbon and polyester film seals and a stainless steel body (see sketch). The valve is designed for use with helium gas at an operating pressure of 10,000 psi, must not leak or develop any structural weaknesses at a test pressure of 15,000 psi, and must not burst even if pressure reaches 25,000 psi. In addition, it must be operative over a temperature range of –300 to 450 F.

TFE seal blocks helium

TFE (Teflon) was selected for the dynamic o-ring seal of the poppet because of its imperviousness to helium and its self-lubricating



TFE o-ring, *Mylar poppet seal, and stainless steel body permit helium valve to operate at 10,000 psi over a temperature range of –300 F to 450 F.*

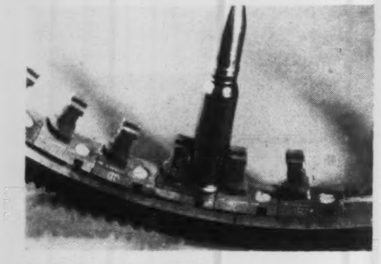
properties. This self-lubricating property of TFE combined with its low coefficient of friction, extends the life of the o-ring and eliminates maintenance. In contrast, ordinary rubber seals are not impervious to helium and must frequently be lubricated.

Polyester film seal has good impact properties

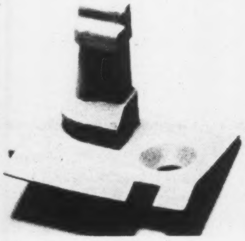
In this valve design the poppet end seal must withstand the sudden closing of the poppet and must not shatter at low temperatures. Laminated polyester film (Mylar) was selected for this seat because of its high impact strength (52 in-lb) and its resiliance at low temperatures. In evaluation tests, several other seal materials became brittle and failed at low temperatures. However, the polyester film seal did not fail during continuous flexing at -320 F.

17-7PH body has high strength

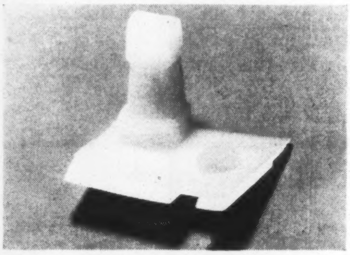
A 17-7PH stainless steel was selected for the body of the valve because of the need for a material with high yield and impact strength. In order to withstand 25,000 psi without bursting, a conventional stainless steel would have to have a wall thickness of 1.125 in. However, by using the 17-7PH steel, wall thickness can be safely reduced to 0.50 in. The 17-7PH steel has better impact strength than other stainless steels even when it is heat treated to obtain high strength. Good impact properties are especially important in this application as high impact loads are created when the poppet slams open and closed.



Retainer assembly.



Old design.



New design.

Nylon Retainers Cut Weight and Cost of Ammunition Storage System

$50 CITATION

Paul Krauss, Product Design Engineer, Missile & Space Vehicle Dept.
General Electric Co., Burlington, Vt.

■ Use of nylon in the redesign of retainer partitions for ammunition storage systems in reciprocating guns has resulted in a 60% saving in weight of components, a 5 to 1 improvement in part life, and a 94% reduction in manufacturing cost. Dimensions of the retainer partitions are critical, since the part has to handle live ammunition, fired cases and dummy rounds, all of which may vary slightly in diameter.

Why nylon?

Retainer partitions were originally precision cast from 355-T6 aluminum because of its high strength and light weight. Lubricants were used to provide smooth guiding surfaces for the aluminum partitions.

In spite of the good tensile strength of this aluminum alloy, a high percentage of retainer partitions broke under the force of shell casings entering the partitions for storage. Efforts to solve the problem by increasing cross section were unsatisfactory because of the resulting increase in weight.

A material for this part would have to have high impact and flexural strength, be lightweight, have a smooth external guiding surface, and be able to withstand temperatures from -65 to 165 F to prevent breakage of the part and subsequent jamming of the system. The material would also have to be low in cost and easy to fabricate.

Nylon, TFE and CFE resins were considered as possible materials for the part. TFE resin could not be molded into the configuration of the part. Nylon was chosen over CFE because of its higher tensile and flexural strengths, and its lower cost.

Although aluminum has greater tensile strength than nylon, nylon's resiliency is better for this application since the plastics partitions can handle slight variances in round diameters without binding or breaking. Also, the low friction characteristics of nylon provide an excellent guide surface without lubrication. Environmental tests show that the nylon partitions retain their strength, elasticity and surface finish over the temperature range of -65 to 165 F

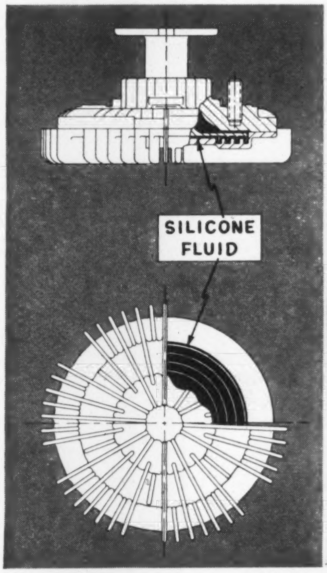
A limited number of reprints of this report are available at 50¢ each.

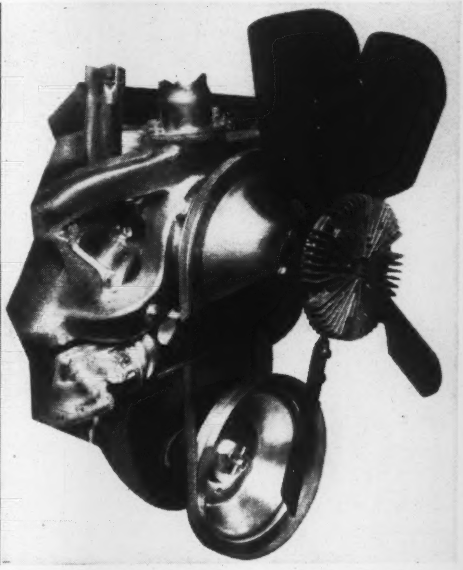
first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 62





SAVES POWER; STOPS NOISE

The ever increasing number of accessories on present day cars compels automotive engineers to look constantly for ways of effecting horsepower savings and, at the same time, improve performance. An excellent example of power saving equipment is the silicone fluid-containing, Viscous Fan Drive made by Eaton Manufacturing Company.

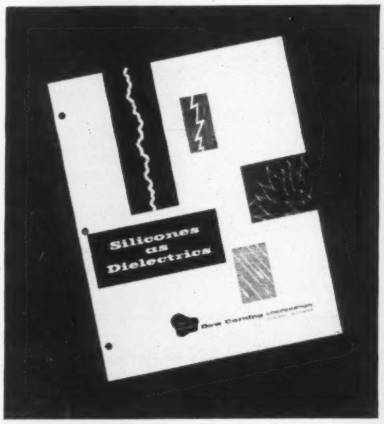
The Problem: Conventional fan drives use most horsepower at engine speeds when cooling is needed least. At low road speeds, need for fan cooling the motor is greatest. At high speeds, ram air helps cool the radiator and cooling requirements are lower.

The Solution: A fan that provides increased air flow at low speeds and reduces it at high speeds. This is effectively accomplished through a fan drive with a silicone fluid coupling interposed between the drive pulley and the fan.

The Result: At low speeds, the silicone fluid coupling acts as a direct drive. As engine speed increases, controlled slippage occurs causing the fan to be held at a speed predetermined to give peak efficiency. This speed is also below the rpm at which objectionable noise occurs.

Thus the Eaton Viscous Fan Drive with Dow Corning silicone fluid makes more horsepower available by cutting power requirements, and reduces fan noise at cruising speeds. This unit makes it possible to increase cooling capacity at idle or low speeds through the use of larger fans or higher fan-to-engine speed ratios.

Dow Corning silicone fluids are specified for this and many other automotive, marine, aircraft and missile accessories because they possess the unique combination of properties: exceptionally resistant to oxidation and to breakdown due to shear; do not gum, evaporate, thicken or thin. Available in many viscosities, they retain near-constant viscosity—show little change due to temperature variations. *No. 633*

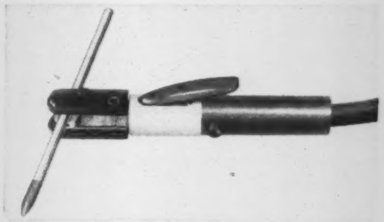


Guide To Silicone Dielectrics

Whether your field is electrical or electronic, you will find this 12-page guide to "Silicones as Dielectrics" an invaluable reference. Just off the press, this current revision is designed to help you select silicone products that will increase the reliability and versatility of your designs.

Arranged for easy reference, this brochure is a guide to more specific product information . . . gives general properties and uses of: rigid and resilient molded parts, laminates, tapes, flexible and rigid sheeting, surface coatings, wire coverings, fillers, impregnants, sealers and encapsulating compounds. Reliable laboratory data backed by actual field experience is provided for each physical form.

This profusely illustrated guide to silicones as dielectric materials will simplify your selection of the best silicone product for each application. To obtain your personal copy, please circle .... *No. 634*

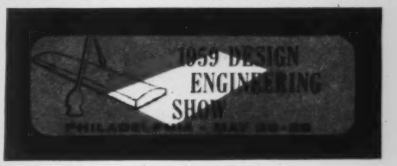


Increase Life, Keep Weight Low

Heat cycling and temperatures as high as 1000 F don't impair the effectiveness of silicone-glass laminated parts. What better proof of their heat stability than this successful use on torches produced by Arcair Co., Lancaster, Ohio?

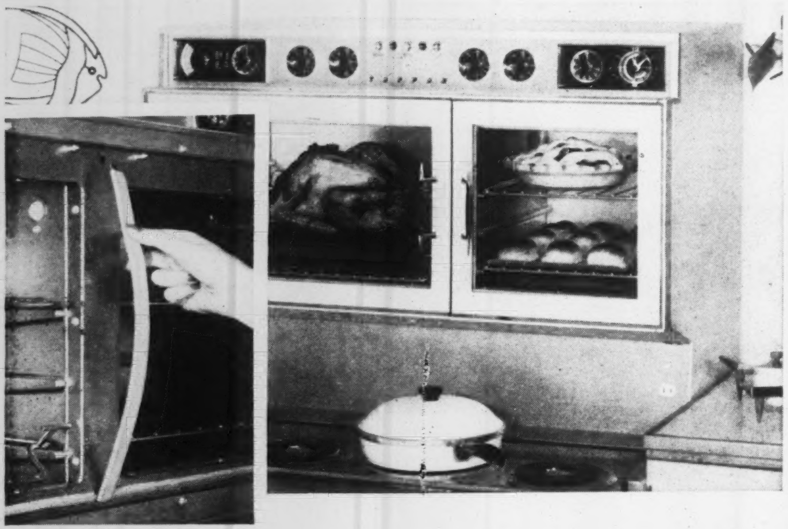
Arcair has used silicone resin laminated insulating parts on all its *(Cont. Pg. 2)*

SEE US AT BOOTH 1510



FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE ☞



MORE DURABLE OVEN SEAL

Rubber gaskets and seals for ovens, frypans and other "hot" appliances require an extra margin of durability. Designers are delivering this durability and the extra consumer-appeal that goes with it by specifying Silastic®, the Dow Corning silicone rubber.

The smart, new Tappan "400" series kitchen range is one of the newer models utilizing silicone rubber. Strikingly new in design, and available as both built-in and free standing models, this range features durable Silastic oven door gaskets which housewives can easily remove for cleaning and re-install.

Tappan designers chose Silastic because it efficiently seals in heat and stays new looking longer than other rubbery materials. Serviceable at temperatures up to 500 F, the silicone rubber door gaskets can be expected to retain their original resiliency, shape and appearance despite repeated exposure to high heat and any number of washings. *No. 635*

SILICONE GLASS *(Continued)*

torches for over four years. According to the designers, the use of silicone-glass parts has materially increased the life and reliability of these torches . . . helped keep torch weight to a minimum.

The laminated parts are used as electrical insulation on the torch heads where welding currents range to 1400 amperes or higher and temperatures are in the range of 1000 F. The torches are ordinarily used for five-minute periods followed by a brief respite. They are frequently employed around the clock, particularly in heavy-duty foundry operations.

The Arcair torches also feature a silicone-glass laminate sleeve as the handpiece to protect the operator against near 600 F heat. Laminates used here vary in thickness from 1/16 to 1/8 inches.

Arcair not only proved silicone-glass superior to loaded phenolics and other materials as an *insulating* material . . . but found that its strength-to-weight ratio at high temperatures (greater than many light metals) helped keep the torches as light as possible. The company produces a complete line of torches for applications ranging from foundry operations to light-duty maintenance. *No. 636*

new literature and technical data on silicones

Performance Proved Dow Corning silicone lubricants can help you solve problems created by adverse operating conditions. Designed for reliable service over wide temperature spans, Dow Corning silicone lubricants are used in applications ranging from food freezers to core oven conveyors — at temperatures as low as —100 F, as high as +500 F. General properties and applications for silicone oils and greases are compiled in an 8-page brochure. *No. 637*

●

Syl-off Saves — Packages designed for sticky products can now couple new functionality with attractiveness through the use of Syl-off coated papers, paperboard, liners, wrappers, and interleaving. Syl-off, the Dow Corning silicone paper coatings, provide the fastest, easiest release possible for sticky products from asphalt to rubber. For more information on properties, applications and sources of supply, circle .... *No. 638*

●

A Handy Key that might open the door to effective solutions to your design problems — the cross-indexed Reference Guide To Dow Corning Silicones. This 16-page brochure details properties and enumerates uses of the many different types of products designed for diverse applications — for example, fluids, dielectrics, protective coatings, release agents, water repellents and Silastic, the Dow Corning silicone rubber. *No. 639*

●

A Service Designers Couldn't Give — maintenance. Specifying silicone based paints for the products you design cuts protective maintenance costs for your customers. A new brochure explains why silicone based paints last longer — contains case histories illustrating the protection given against weathering, the resistance offered against corrosion, and the increased heat stability available through the use of silicone based paints. *No. 640*

●

Rubber From Rock, a full color sound movie, points up ways you can use silicone rubber to improve performance and design of mechanical and electrical equipment. It explains how Silastic, the Dow Corning silicone rubber made from quartzite, retains its rubber-like properties from —130 to over 500 F in automotive, aircraft and industrial applications. *No. 641*

●

Keep 'Em Cool with Silicone Fluids. Designers of electronic assemblies are using silicone fluids as dielectric coolants to solve problems created by extreme environmental conditions and miniaturization in control circuitry of aircraft, missiles, submarines, and industrial communication systems. A data sheet contains complete information for designers. *No. 642*

Dow Corning Corporation, Dept. 7017, Midland, Michigan

Please send me: 633 634 635 636 637
638 639 640 641 642

NAME ____________________

TITLE ____________________

COMPANY ____________________

STREET ____________________

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SILICONE NEWS is published for design and development engineers by

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

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CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST GOBAIN, PARIS

Wrought Al-Mg-Si and Al-Zn-Mg Alloys—A Materials Data Sheet

Type ➡	6061	6063	7075	7079
COMPOSITION, %	Mg 0.8–1.2, Si 0.4–0.8, Cr 0.15–0.35, Cu 0.15–0.40	Mg 0.45–0.9, Si 0.2–0.6	Zn 5.1–6.1, Mg 2.1–2.9, Cu 1.2–2.0, Cr 0.18–0.40	Zn 3.8–4.8, Mg 2.9–3.7, Cu 0.4–0.8, Mn 0.1–0.3, Cr 0.1–0.25
PHYSICAL PROPERTIES				
Density, lb/cu in.	0.098	0.098	0.101	0.099
Melting Temp Range, F	1080–1200	1140–1205	890–1180	900–1180
Ther Cond (77 F), Btu/hr/sq ft/°F/ft	99	111	70 (T6)	70 (T6)
Coef of Ther Exp, per °F				
68–212 F	13.0 x 10^{-6}	13.0 x 10^{-6}	12.9 x 10^{-6}	13.1 x 10^{-6}
68–572 F	14.1 x 10^{-6}	14.2 x 10^{-6}	14.4 x 10^{-6}	14.2 x 10^{-6}
Specific Heat, Btu/lb/°F	0.23	—	0.23	—
Elec Res (68 F), microhm-cm	3.8 (O)	3.1 (T6)	5.7 (T6)	5.5 (T6)
MECHANICAL PROPERTIES				
Mod of Elast in Tension, psi	10.0 x 10^{6}	10.0 x 10^{6}	10.4 x 10^{6}	10.3 x 10^{6}
Ten Str, 1000 psi				
Annealed (O)	18	13	33	—
Heat Treated	35 (T4), 45 (T6)	25 (T4), 35 (T6)	83 (T6)	78 (T6)
Yld Str (0.2% offset), 1000 psi				
Annealed (O)	8	7	15	—
Heat Treated	21 (T4), 40 (T6)	13 (T4), 31 (T6)	73 (T6)	68 (T6)
Elong (in 2 in.), %				
Annealed (O)	25	—	17	—
Heat Treated	22 (T4), 12 (T6)	22 (T4), 12 (T6)	11 (T6)	14 (T6)
Hardness (Brinell)				
Annealed (O)	30	25	60	—
Heat Treated	65 (T4), 95 (T6)	—, 73 (T6)	150 (T6)	145 (T6)
Endurance Limit, 1000 psi				
Annealed (O)	9	8	—	—
Heat Treated	14 (T4), 14 (T6)	—, 10 (T6)	23 (T6)	23 (T6)
Shear Str, 1000 psi				
Annealed (O)	12	10	22	—
Heat Treated	24 (T4), 30 (T6)	—, 22 (T6)	48 (T6)	45 (T6)
FABRICATING PROPERTIES				
Annealing Temp, F	775	775	775	—
Solution Temp, F	970	—	880	830
Aging Temp, F	340	350–450	250	240–250
Machinability[a]	B (T4, T6)	B (T4, T6)	A (T6)	A (T6)
Relative Weldability[a]				
Torch	A	A	D	D
Inert Arc	A	A	C	C
Elec Res	A	A	C	C
CORROSION RESISTANCE	Compared with other aluminum alloys, these alloys have high resistance to rural atmospheres, good resistance to industrial and marine atmospheres. Degree and nature of attack in other environments is greatly influenced by heat treatment. Clad alloys have corrosion resistance of the cladding alloy		Compared with other aluminum alloys, these alloys have good corrosion resistance to rural atmospheres but are attacked by industrial and marine atmospheres. In other environments, they are generally less corrosion resistant than other wrought aluminum alloys and are frequently clad. Clad alloys have corrosion resistance of the cladding alloy	
AVAILABLE FORMS	Sheet, plate, wire, rod, bar, pipe, tubing, rolled and extruded shapes forgings	Extruded shapes, tube, pipe	Sheet, plate, wire, rod, bar, extruded shapes, tube, pipe, forgings	Forgings, extrusions, sheet, plate
USES	Transportation equipment, heavy duty structures, marine uses, pipe, furniture	Pipe, railings, hardware, architectural uses	Structural parts for aircraft	

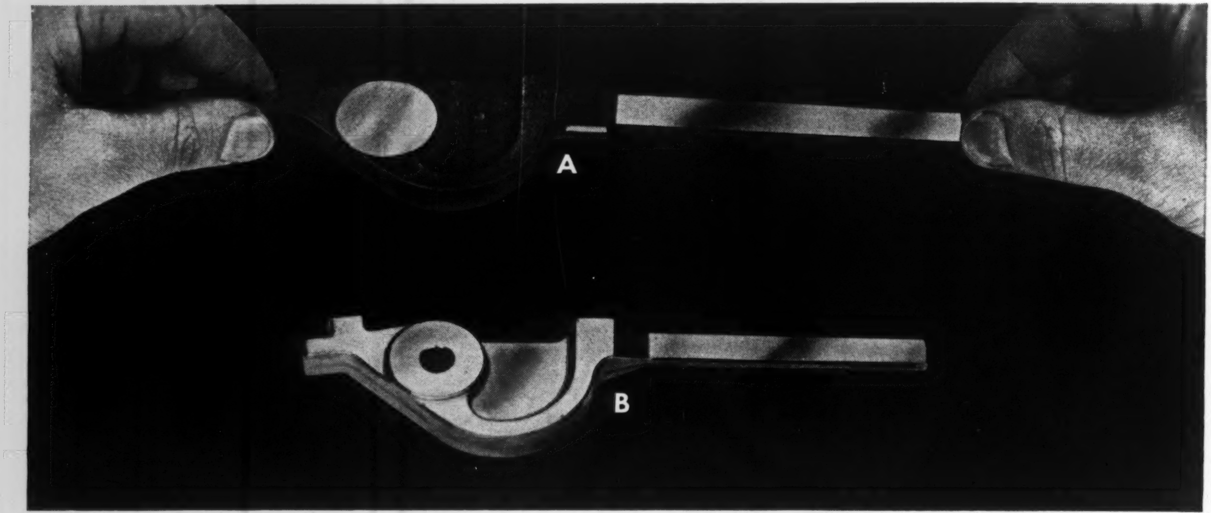
---

[a] Letter A indicates most favorable, B less favorable, etc. Relative to aluminum alloys only.

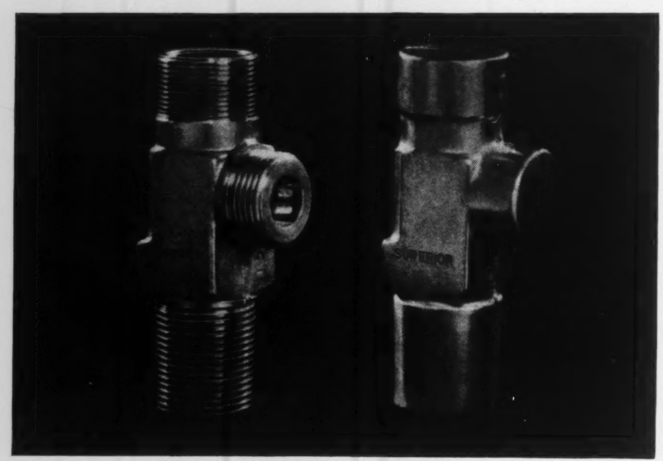
◀ For more information, circle No. 535

QUALITY CONTROL PLUS SAVINGS

Value analysis suggested the use of a die-pressed forging. The result: an 85% cost reduction and a stronger, tougher part.



SWITCH BLADE in overspeed limiting device on large General Electric motor-generators was originally an assembly **A**—an arm brazed to a brass casting which was machined, slotted, and drilled. After review in the company's Value Analysis program, assembly was replaced by Anaconda die-pressed brass forging **B.** The superior strength of twice-wrought metal made possible a one-piece part. The excellent finish and consistent dimensional accuracy of the die-pressed forgings eliminated all machining but the drilling operation. The over-all cost is 15% of the original part.



VALVES FOR CHLORINE AND FLUORINE shipping containers must have unusual corrosion resistance and high strength. Superior Valve & Fittings Co., Pittsburgh, specialists in handling halogens, looked for a forging alloy that would be suitable. American Brass Company metallurgists suggested die-pressed forgings of a slightly modified Everdur®-1014, an aluminum-silicon bronze, for this chlorine-fluorine service, and this customer is finding wide use for it in other severe service, too. The twice-wrought metal of Anaconda die-pressed forgings has dense structure to prevent leaks—strength and toughness to take rough handling. Yet it can be machined in automatic-chucking machines resulting in good cost control.

THE vital job of controlling quality *and* costs may be easier than you think. Anaconda technical specialists will gladly help you find the right alloy and mill form to do both. See your American Brass Company representative or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 5940

DIE-PRESSED FORGINGS SPECIAL-SHAPE TUBES
EXTRUSIONS FABRICATED METAL PARTS

products of

ANACONDA®

made by The American Brass Company

For more information, turn to Reader Service Card, circle No. 465

What's new IN MATERIALS

Edited by
John A. Mock

High temperature resistance *of graphite cloth is graphically shown by this demonstration in which an oxyacetylene torch burns right through a stainless steel mesh but only causes a glow on the new cloth.*

High Temperature Fibers, Felts Now Made of Pure Graphite

■ Graphite textiles, in almost any form desired—fiber, yarn, braids, felts or woven fabrics—can now be produced.

Fibers in such textiles are 99.9% pure graphite. Their crystalline structure is similar to that of conventional manufactured graphite. Thus the flexibility of textiles is now coupled with the high temperature strength, chemical inertness, high electrical and thermal conductivity, and self-lubricating characteristics of graphite.

Fabrics and fibers are available in developmental quantities from National Carbon Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17. Developmental price is $1.50 per sq ft.

The starting material for the graphite textile is a synthetic fiber, such as rayon. Graphite fibers can be produced directly from the rayon fiber, or the fiber can be twisted, felted or woven, before graphitizing, into the end textile form desired. The organic fiber or fabric is then processed at temperatures on the order of 5400 F to graphitize the fiber and form the finished graphite textile.

Properties

Graphite fibers have the same basic properties as conventional manufactured graphite. Individual graphite yarns have shown tensile strengths as high as 15,000 psi. Properties of fabrics, of course, depend on the type of fiber and weave.

Like conventional graphite, graphite fibers increase in strength with temperature up to a maximum at about 4500 F. At about 750 F and higher, the material must be protected from oxidation. Graphite does not melt, but sublimes at about 6600 F.

Graphite is unaffected by low temperatures. Consequently, graphite fabrics are as flexible at the -320 F temperature of liquid nitrogen as they are at room temperature.

Graphite is extremely resistant to thermal shock because of its low thermal expansion and high thermal conductivity. It has good electrical conductivity, good nuclear moderating properties, and a low neutron-capture cross section. It is resistant to practically all acids, alkalis and organic compounds, except those that are highly oxidizing.

Applications

One of the most promising applications for graphite fabrics is as a reinforcing material for plastics, ceramics or refractories for high temperature uses, such as rocket nozzles and nose cones.

Potential chemical uses include bag-type filters for hot non-oxidizing gases; components for handling corrosive fluids; electrostatic precipitators; high temperature curtain walls; and flame arresters.

Electrical applications may include resistance heating elements, both for industrial high temperature use and for low temperature space heating. Electrical connectors can be provided by metal plating, spraying or vacuum deposition.

Mechanically, the combination of high temperature strength and self-lubricity may make the material useful for valve packing and gasket materials for high temperature seals such as those required in jet engines.

(more What's New on p 150)

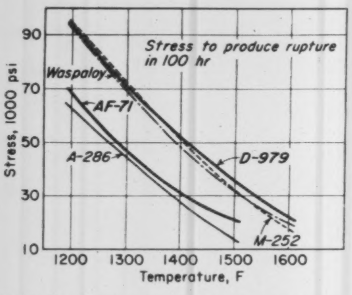


Fig 1—*Stress-rupture properties of Alloys AF-71 and D-979 compared to those of three other high temperature alloys.*

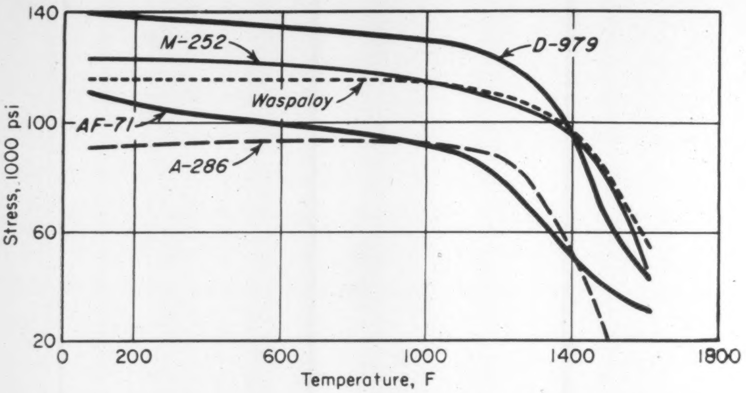


Fig 2—*Yield strength (0.2% offset) of Alloys AF-71 and D-979 compared to that of three other high temperature alloys.*

Two New Superalloys for High Temperatures

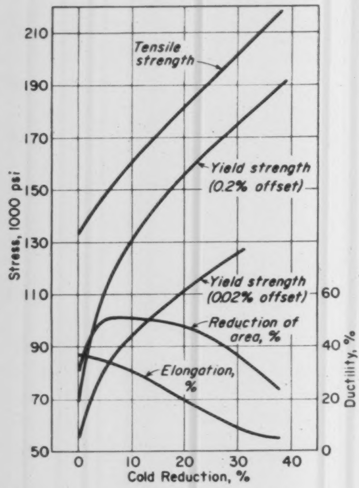


Fig 3—*Effect of cold rolling on room temperature tensile properties of Alloy AF-71.*

■ Two new superalloys, which are said to have excellent properties at high temperatures, have been developed by Allegheny Ludlum Steel Corp. The alloys, designated D-979 and AF-71, were developed primarily for aircraft gas turbines, but are also suggested for use in missiles, airframes and commercial turbines.

Both of the superalloys are precipitation hardening and are available in the form of billet, bar, wire, sheet, strip and foil. Alloy AF-71 is melted by a conventional arc process, and alloy D-979 is produced by Allegheny's vacuum consumable-electrode remelting process.

Alloy D-979

Developed specifically for production by the vacuum consumable-electrode remelting technique, this alloy is essentially an iron-nickel-chromium-base austenitic alloy (see Table 1). It is made precipitation hardenable by additions of titanium and aluminum, and solution-strengthened with molybdenum and tungsten.

Properties—According to Allegheny, tensile and stress-rupture properties of D-979 are equal or superior to those of the commonly used nickel-base, precipitation hardening, high temperature alloys (see Fig 1 and 2). Major advantage of this alloy (for use as shafts and disks in aircraft gas turbines) is its combination of high tensile properties, excellent stress-rupture properties, and producibility in large sizes (thus far, ingots up to 20 in. in dia and weighing up to 5500 lb have been produced).

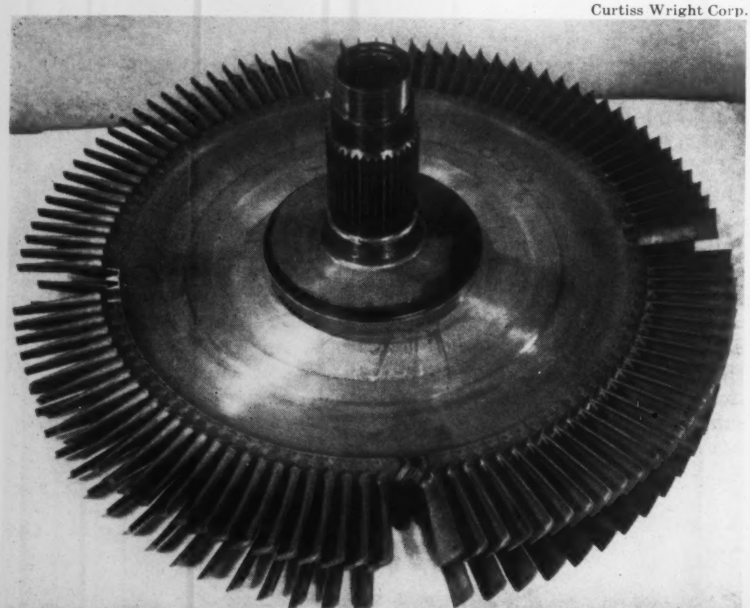
Tensile and stress-rupture properties of heat treated sheet, bar and forgings are given in Tables 2 and 3.

Fabrication — Alloy D-979 is readily forged and welded. Although sheet material is more easily welded than plate (stress-rupture and tensile tests on welded sheet show joint efficiencies of 95 to 100%), plate material up to $\frac{5}{8}$ in. thick can be satisfactorily welded by the tungsten electrode, inert-gas shielded technique.

Heat treatment — The heat treatment for Alloy D-979 varies according to whether 1) opti-

Turbine wheel *is made of alloy D-979.*

Curtiss Wright Corp.



mum tensile plus creep-rupture strength or 2) maximum creep-rupture strength alone is desired. For optimum tensile plus creep-rupture strength, the alloy is solution treated 1 hr at 1850 F, oil quenched, then double aged by holding 6 hr at 1550 F, air cooling, holding 16 hr at 1300 F, and air cooling. For maximum creep-rupture strength alone, the alloy is solution treated 1 hr at 2050 F, oil quenched, then double aged by holding 8 hr at 1550 F, air cooling, holding 16 hr at 1300 F, and air cooling.

According to Allegheny, the rapid cooling from 1850 or 2050 F dissolves both the age hardening constituents and the solid solution strengthening elements. It also puts the alloy in its most formable condition and gives it its lowest hardness. Holding 8 hr at 1550 F during the double aging treatment insures that precipitation will occur primarily at grain boundaries and thereby provide high ductility.

Alloy AF-71

This alloy, developed under an Air Force contract, is essentially an iron-manganese-chromium, age hardening, austenitic alloy. It is stabilized with additions of carbon and nitrogen, and strengthened with molybdenum, vanadium and boron (see Table 1).

Properties—According to Allegheny, tensile and stress-rupture properties are superior to those of other more highly alloyed materials (see Fig 1 and 2). The alloy maintains its strength at temperatures as high as 1500 F and, unlike other precipitation hardening materials, does not exhibit a sharp drop-off in strength above the over-aging temperature. It can be cold worked to tensile strengths above 200,000 psi (see Fig 3), and properties of the cast alloy are said to be equal to or better than those of the wrought material. Thus far, AF-71 has been cast in ingots up to 23 in. square and weighing 6300 lb.

Major advantage of this alloy for high temperature turbines is its combination of good high temperature strength, low alloy content and excellent forgeability. Tensile and stress-rupture properties of sheet, bar and forgings are given in Tables 2 and 3.

Heat treatment—Standard heat treatment for AF-71 involves solution treating 1 hr at 2050 F, water quenching, then aging 32 hr at 1325 F and air cooling.

(more What's New on p 152)

TABLE 1—COMPOSITION OF NEW SUPERALLOYS (%)

Alloy ➡	D-979	AF-71
Carbon	0.05	0.25
Manganese	0.30	18.0
Silicon	0.30	0.30
Chromium	15.0	12.5
Nickel	45.0	—
Molybdenum	4.0	3.0
Tungsten	4.0	—
Titanium	3.0	—
Aluminum	1.0	—
Nitrogen	—	0.20
Boron	0.01	0.20
Iron	Bal	Bal

TABLE 2—TENSILE PROPERTIES OF NEW SUPERALLOYS

Alloy, Form ➡	Alloy D-979[a]			Alloy AF-71[b]		
	Sheet	Bar	Forgings	Sheet	Bar	Forgings
ROOM TEMPERATURE						
Tensile Strength, 1000 psi	195	200	195	148	159	148
Yield Strength, 1000 psi						
0.02% Offset	115	122	114	84	84	77
0.2% Offset	138	142	134	106	109	100
Elongation, %	17	17	14	18	24	19
Reduction of Area, %	—	34	17	—	37	20
1300 F						
Tensile Strength, 1000 psi	126	126	128	—	—	—
Yield Strength, 1000 psi						
0.02% Offset	90	88	88	—	—	—
0.2% Offset	113	114	114	—	—	—
Elongation, %	10	22	16	—	—	—
Reduction of Area, %	—	42	26	—	—	—

[a] Heat treatment: 1 hr at 1850 F, oil quench, 6 hr at 1550 F, air cool, 16 hr at 1300 F, air cool.
[b] Heat treatment: 1 hr at 2050 F, water quench, 32 hr at 1325 F, air cool.

TABLE 3—STRESS-RUPTURE PROPERTIES OF NEW SUPERALLOYS

Alloy, Form ➡	Alloy D-979[a]				Alloy AF-71[b]			
	Stress, 1000 psi	Sheet	Bar	Forgings	Stress, 1000 psi	Sheet	Bar	Forgings
1200 F								
Time to Rupture, hr	90	106	125	168	70	98	74	103
Elongation, %	90	4.5	9.0	4.4	70	2.8	16.0	10.0
Reduction of Area, %	90		9.0	9.4	70		50.0	34.0
1350 F								
Time to Rupture, hr	57	88	202	97				
Elongation, %	57	5.5	2.2	11.0				
Reduction of Area, %	57		12.7	19.0				
1500 F								
Time to Rupture, hr	35	57	82	98	20	81	234	209
Elongation, %	35	3.3	5.2	4.2	20	5.0	19.0	15.8
Reduction of Area, %	35		10.2	9.4	20		53.0	42.9

[a] Heat treatment: 1 hr at 2050 F, oil quench; 8 hr at 1550 F, air cool, 16 hr at 1300 F, air cool.
[b] Heat treatment: 1 hr at 2050 F, water quench, 32 hr at 1325 F, air cool.

Highly Fluorinated Rubber May Compete with Viton

■ A new fluorinated elastomer now joins five other materials in this newest family of rubbers developed to withstand corrosive fluids and extremes of temperature. The rubber is called Fluorel and is available from the Chemical Div. of Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn. It sells for $15 per lb.

The developer has not revealed composition of the material, except to state that it is a fully saturated fluorinated polymer containing more than 60% fluorine by weight.

The new elastomer will probably be most competitive with Du Pont's Viton (a linear copolymer of vinylidene fluoride and hexafluoropropylene). Comparative data on the properties of the two materials are given in Table 1.

Many potential uses

Aircraft, missiles—Since Fluorel has good resistance to diester and petroleum-base lubricants, hydraulic fluids, aromatic fuels, hydrogen peroxide and red fuming nitric acid, it should find use in many aircraft and missile parts, including mechanical seals, fuel cells, fire walls, air ducts, hydraulic hose and sealants.

Chemical equipment—The developer says Fluorel has potential use as o-rings, lip seals, shaft seals and liners in pumps transferring all types of industrial chemicals. The fluorinated rubber may also be useful for seals and diaphragms in metering pumps handling highly aromatic automotive gasolines.

Automobiles—In spite of Fluorel's high price, 3M believes its chemical and thermal stability and low compression set may make it useful for such automo-

(continued on p 154)

TABLE 1—PROPERTIES OF TWO FLUOROELASTOMERS COMPARED

Type	Viton	Fluorel
ORIGINAL MECHANICAL PROPERTIES		
Tensile Strength, psi	2375	**2300**
Elongation, %	350	**320**
Hardness (Shore A, 77 F)	66	**65**
LOW TEMPERATURE PROPERTIES		
Brittle Point, F	−47	**−40**
Gehman T_{10}, F	−7	**+3**
AFTER AGING IN RED FUMING NITRIC ACID[a]		
Ten Str Chg, %	—	**−55.6**
Elong Chg, %	—	**+62.5**
Volume Chg, %	+16.0	**+64.0**
AFTER AGING IN JP-4 FUEL[a]		
Ten Str Chg, %	−3.0	**−6.0**
Elong Chg, %	0.0	**−3.1**
Volume Chg, %	+0.8	**0.0**
AFTER AGING IN CARBON TETRACHLORIDE[a]		
Ten Str Chg, %	−15.0	**−15.7**
Elong Chg, %	−17.0	**−1.5**
Volume Chg, %	+1.3	**+2.0**
AFTER AGING IN OS-45 FLUID[b]		
Ten Str Chg, %	−38.0	**−5.2**
Elong Chg, %	−33.0	**−7.8**
Volume Chg, %	+11.1	**+3.0**
AFTER AGING IN ASTM NO. 3 OIL[c]		
Ten Str Chg, %	−5.0	**+9.6**
Elong Chg, %	0.0	**+12.5**
Volume Chg, %	+4.3	**+3.0**

[a] Aged 7 days at rm temp.
[b] Aged 7 days at 400 F.
[c] Aged 7 days at 300 F.

Fluoroelastomers— How Do They Rate?

Since the spring of 1957 a great deal of evaluation work has clarified the status of the various fluoroelastomers. Properties of five types were first reported in M/DE, July '57, p 90. Here's how they rate at present:

1. Viton-type elastomer is the front runner for combined heat and fluid resistance. From the property data presented here, it appears that 3M's Fluorel can be classed in the same family as Viton. On the other hand, it now looks as though Viton is not so good in radiation resistance—irradiation seems to produce an embarrassingly high compression set.
2. LS-53 — the fluorosilicone rubber—seems the best available material at present for use in jet aircraft fuel and hydraulic systems. In these applications LS-53 has the required temperature and fluid resistance to meet current needs.
3. Kel-F elastomer is primarily used for its matchless resistance to red fuming nitric acid.
4. Of the other two fluoroelastomers reported two years ago, Fluoro-Rubber 1F4 seems to be out of the running, whereas fluorinated polyester has definitely dropped from sight.

MORE WHAT'S NEW IN MATERIALS

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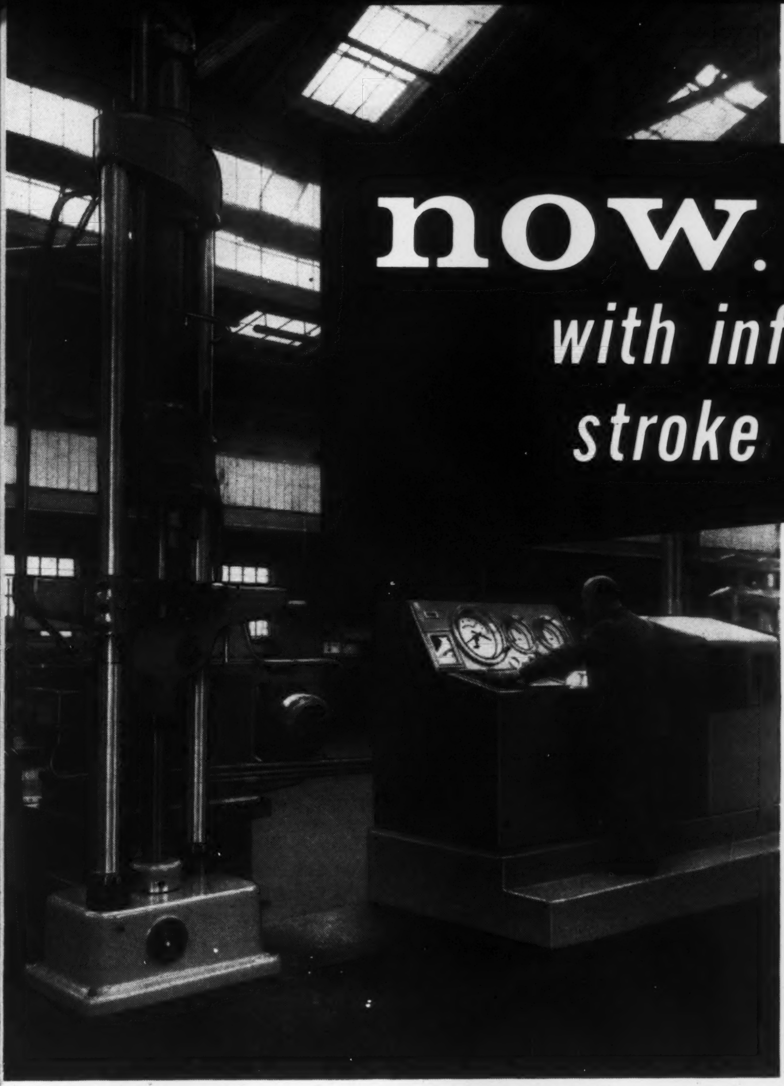

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NEWLY AVAILABLE from Riehle, this Losenhausen hydraulic fatigue testing machine permits complete load and cycle flexibility. Consisting of a console, pulsator and loading unit cylinder, the Losenhausen machine generates strokes up to 10″ at low frequencies and modest strokes can be accommodated at frequencies approaching 1000 cpm.

The console measures and indicates the load developed on each cycle, as either fluctuating in tension or compression or as alternating between maximum compression and tension.

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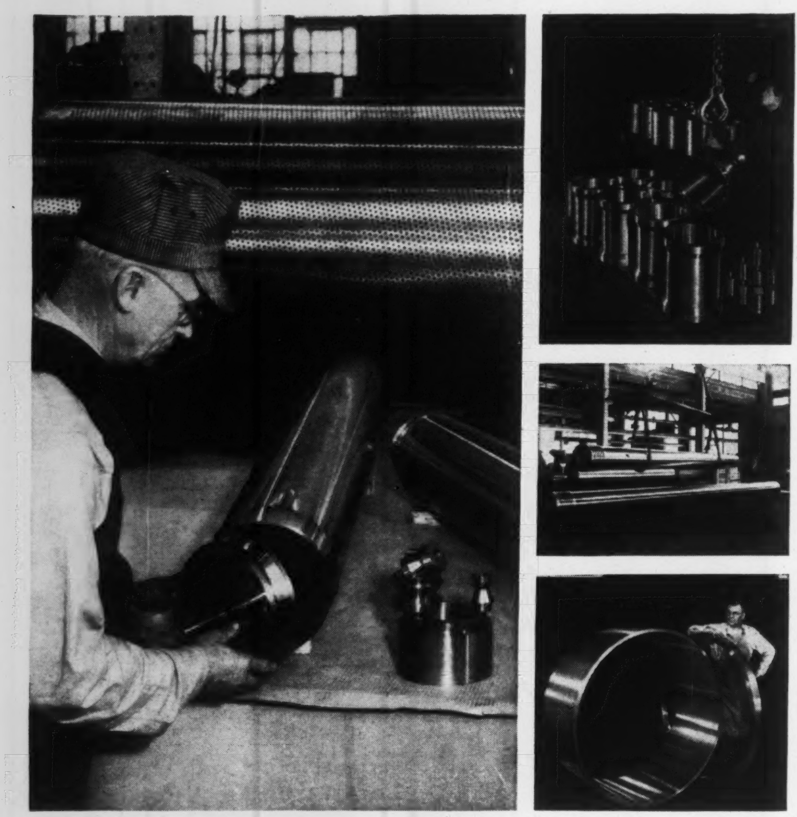

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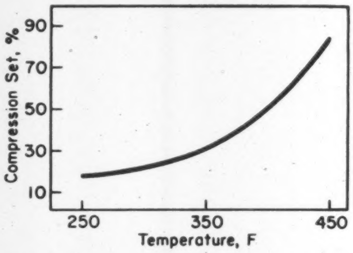


***Fig 1**—Compression set of a Fluorel compound after aging 70 hr at various temperatures.*

tive parts as brake cups and transmission seals.

Properties

One of the most important properties of the elastomer for mechanical goods is its good resistance to compression set. Fig 1 shows compression set of a Fluorel compound after aging 70 hr at various temperatures.

A summary of 3M's findings so far:

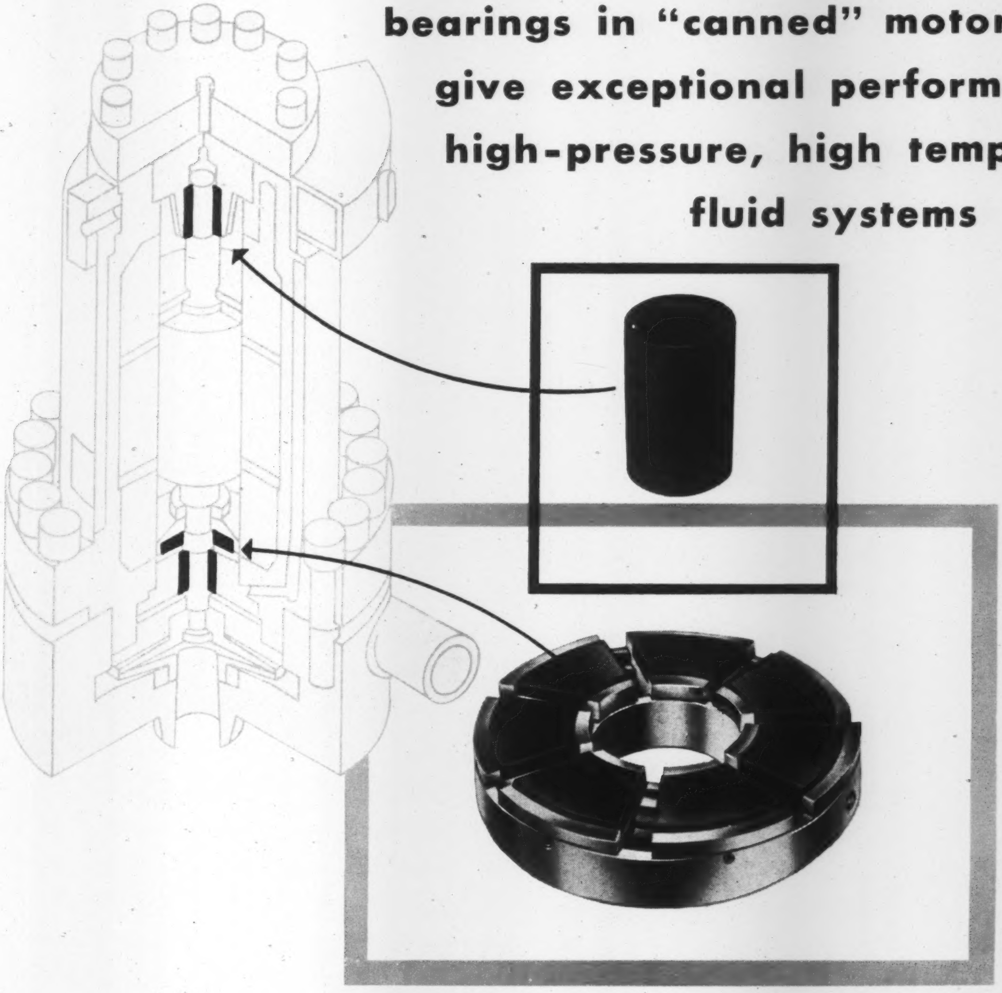
1. Thermal stability—Fluorel compounds can be used continuously at temperatures above 400 F without marked degradation of either molecular structure or related mechanical properties. As temperatures increase to 500 and 600 F, the compounds show significant changes in hardness and elongation.

2. Low temperature properties—Fluorel compounds tend to stiffen rapidly at 0 F, which approximates the glass transition temperature for this copolymer. Thin sections may be bent without cracking at –50 F.

3. Chemical resistance — Properly cured Fluorel compounds show excellent resistance to a wide variety of hot oils, fuels, organic solvents, and strong inorganic acids and bases. Low-molecular-weight carbonyl or carboxyl compounds, such as organic acids, ketones, aldehydes and ethers, are excellent solvents for the raw gum and cause excessive swelling of the vulcanizates. Table 2 shows the volume swell and tensile properties of a Fluorel compound in various types of chemical compounds after 7-day immersion.

4. Weather, ozone resistance—The fluorinated rubber shows no change in physical properties after one year of outdoor exposure in an industrial atmosphere. A Fluorel

water-lubricated GRAPHITAR (CARBON-GRAPHITE) bearings in "canned" motor pumps give exceptional performance in high-pressure, high temperature fluid systems



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5. *Electrical properties*—The fluoroelastomer has electrical properties comparable to those of electrical-grade vinyl chloride polymers. The fluorinated elastomer performs best in low voltage, low frequency applications where chemical and thermal stability are required. Table 3 shows the electrical properties of an amine-cured Fluorel compound.

6. *Flammability* — Because of its

TABLE 2—EFFECTS OF FLUIDS ON FLUOREL[a]

Fluid ⬇	Ten Str Chg, %	Elong Chg, %	Vol Chg, %
SOLVENTS			
Acetone, 77 F	—	—	+374.0
Aniline, 77 F	−25.0	−12.0	+5.0
Benzene, 77 F	−13.9	−6.2	+22.0
Carbon Disulfide, 77 F	−8.6	+15.6	+3.0
Cyclohexanone, 77 F	—	—	+350.0
Dioxane, 77 F	—	—	+205.0
Ethyl Acetate, 77 F	—	—	+375.0
Ethyl Alcohol, 77 F	−16.5	+12.5	+2.0
Petroleum Ether, 77 F	−6.5	0.0	+3.0
Trichloroethylene, 77 F	−20.0	−10.0	+6.0
FUELS AND OILS			
GE 81406, 350 F	−5.5	−6.2	0.0
MIL-0-5606, 350 F	−23.9	−17.0	+6.0
MIL-0-7808, 400 F	−5.2	−17.0	+12.0
MIL-0-8200, 400 F	+4.3	+6.2	+3.0
Skydrol 500, 300 F	—	—	+320.0
Tricresyl Phosphate, 300 F	−36.9	0.0	+22.0
Pyranol, 300 F	+11.9	+9.3	+5.0
Ref Fuel B, 77 F	−13.9	+4.6	+3.0
High Energy Fuel No. 3, 325 F	−20.4	−12.5	+8.0
ACIDS AND BASES			
Sodium Hydroxide (50%), 77 F	+13.0	+4.6	0.0
Acetic Acid (glacial), 77 F	—	—	+180.0
Hydrochloric Acid (37%), 77 F	−6.0	−21.8	+32.0
Hydrofluoric Acid (48%), 77 F	−4.3	+12.5	+12.0
Nitric Acid (90%), 77 F	−13.0	+6.2	+24.0
Phosphoric Acid (85%), 77 F	+17.3	+17.0	0.0
Sulfuric Acid (fuming), 77 F	−22.6	−9.3	+12.0

[a] Seven days immersion.

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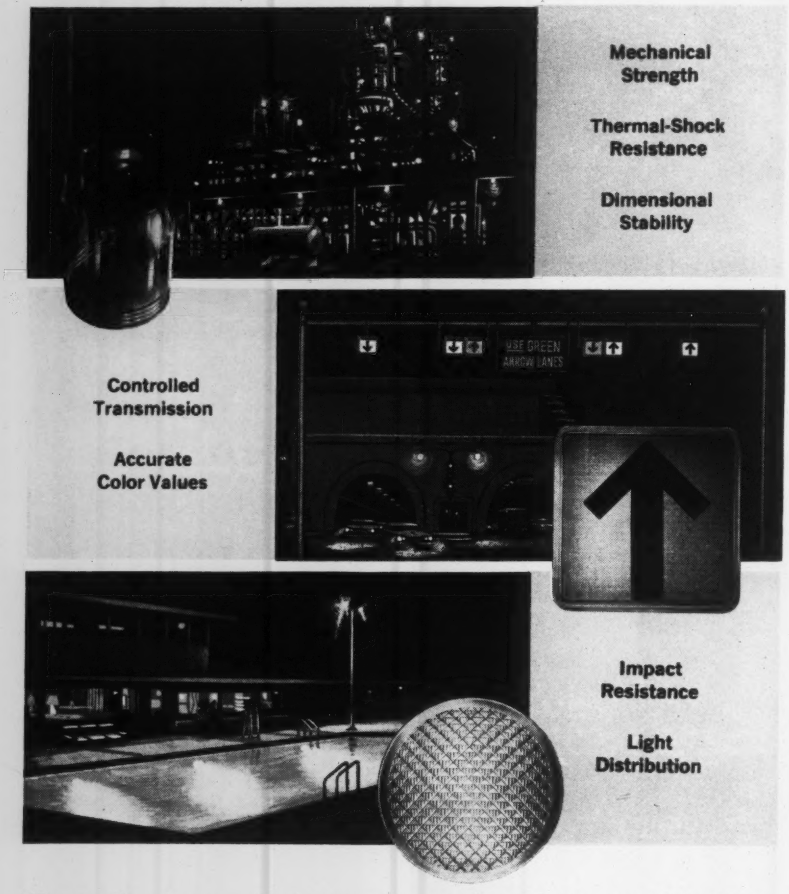

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TABLE 3—ELECTRICAL PROPERTIES OF FLUOREL ELASTOMER

Volume Resistivity, ohm-cm	
50% RH	2.0×10^{13}
90% RH	1.5×10^{13}
Dielectric Strength (short-time), v/mil	630
Dielectric Constant (100 cps)	11.4
Dissipation Factor (100 cps)	0.0125

high fluorine content, Fluorel does not support combustion. Coatings applied to flammable fabrics make them self-extinguishing.

7. *Radiation resistance*—The elastomers are moderately resistant to gamma radiation emitted by cobalt-60. Table 4 shows some mechanical properties of a Fluorel compound after exposure at two dosage levels.

Conventional fabrication

According to the developer, the viscosity of Fluorel gum is designed to provide easy processing on conventional equipment. The recommended molding temperature for the elastomer is 290 to 320 F. Press-cured pieces require a 24-hr postcure at 400 F. Mold shrinkage following postcure averages 2%.

Compounded Fluorel compounds have been extruded successfully in

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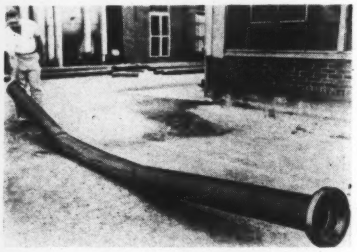

Flexible cast iron pipe—Tubing, pipe (such as that shown here), casings, fittings and special castings made from a newly developed ductile cast iron can be bent and twisted without breaking. Pipe, tubing and other parts made of the cast iron are now commercially available from American Cast Iron Pipe Co., P.O. Box 2603, Birmingham 2, Ala.

Flexible cast iron pipe and tubing are expected to find use in high pressure pumps, process equipment, hydraulic assemblies and textile equipment. A major application for the pipe will be underground gas and water mains.

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4. Smooth, fine grained deposits under bright or semi-bright operating conditions.
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6. Less cyanide decomposition and carbonate buildup at lower operating temperatures.

The Cynorex process, a development of the Harshaw laboratories, provides a fine-grained, ductile bright copper deposit by the use of a single organic brightening agent, utilizing the advantages of current interruption. The addition agent is not removed by activated carbon and has a very wide operating range, resulting in greatly simplified brightness control.

Because Rochelle salts are not required, reduced chromium may be removed continuously, with anode and cathode efficiencies remaining at 100%.

This outstanding process has a record of successful operation, and its unusual characteristics ideally answer your product finishing requirements with wide operating ranges and reduced control requirements.

Contact the Harshaw Branch nearest you. Harshaw Representatives will be happy to discuss with you the application of this process in your plant.

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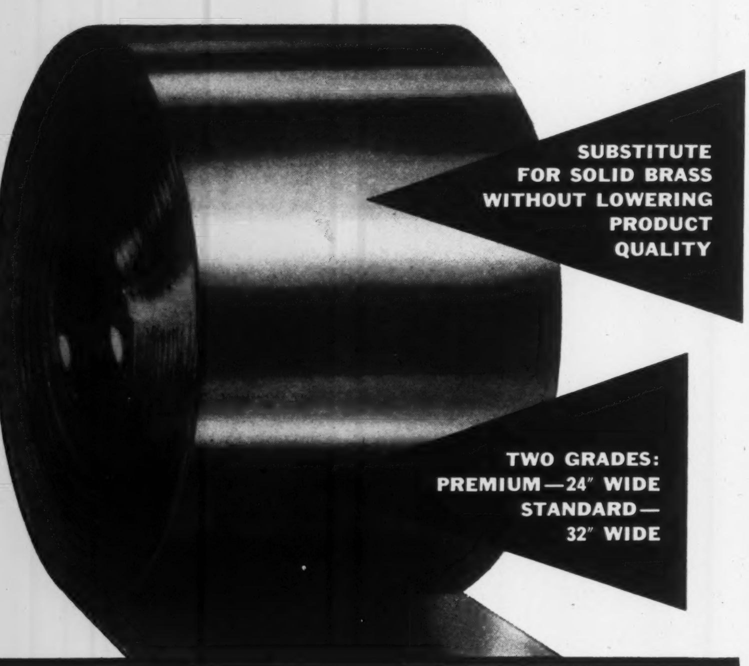
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TABLE 4—RADIATION RESISTANCE OF FLUOREL ELASTOMER

Dosage, megareps ➡	10	100
Tensile Strength, psi	1675	1380
Elongation, %	240	80
Hardness (Shore A)	69	76
Stress at 100% Elong, psi	400	—
Compr Set at Break, %	6	0

a standard rubber tuber at a barrel temperature of 150 F and die temperature of 170 F.

The fluoroelastomer can be bonded to most metals with a silicone-base adhesive. The standard press and oven curing conditions used for vulcanizing Fluorel result in a rubber-to-metal bond strength of 50 psi.

Tungsten Keeps Its Strength at 3600 F

Commercially pure tungsten is considerably stronger than molybdenum from 2500 to 3700 F, recent research indicates. The tensile strength of tungsten is approximately 49,000 psi at 2500 F, compared to 15,000 psi for unalloyed molybdenum. At 3600 F, tungsten has a tensile strength of about 10,000 psi, whereas molybdenum has a tensile strength of about 2200 psi.

Both tungsten and molybdenum are potentially useful as structural materials for very high temperature service, but little information is available on their strengths at temperatures above 2500 F.

This scarcity of information led Robert W. Hall and Paul F. Sikora of Lewis Research Center to investigate the tensile properties of these two metals at temperatures up to 3700 F. Details of their work are presented in Memorandum No. 3-9-59E issued by the National Aeronautics and Space Administration.

How materials rate

The two researchers conducted high temperature tensile tests on sintered tungsten, arc cast unalloyed molybdenum, and two arc cast molybdenum-base alloys. Here is a summary of what they found:

1. An arc cast molybdenum alloy containing 0.46% titanium and 0.07% zirconium had a tensile strength of

New neoprene-jacketed coiled heater cord unharmed by 500,000 stretches

This new neoprene-jacketed heater cord was designed with a built-in coil action that eliminates tangling and tripping hazards between small kitchen appliances and connecting outlets. Concerned with the possible ill effects of continued flexing, the manufacturer subjected it to an acceptance test of 500,000 stretch-and-recovery cycles. Following the test, a careful inspection of the flexed sample revealed no damage to the heater cord —no sign of failure in its neoprene jacket.

Long-term flexibility, the subject of this test, is just one of the advantages offered by the neoprene jacket on this new coiled appliance cord. Neoprene also provides good resistance to the harmful effects of heat, food chemicals, cooking oils, greases, and other common household agents that quickly attack ordinary jacketing materials.

Neoprene synthetic rubber, made by Du Pont for 25 years, has become a preferred material in the design and manufacture of many parts used by the appliance industry. Compressible gaskets, oil-resistant seals, flexible boots, durable wire jacketing . . . all benefit from its unmatched combination of important properties. Learn more about neoprene and the Du Pont family of synthetic rubbers. Write to E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. MM-5, Wilmington 98, Del.

Neoprene-jacketed coiled cord (type HPN) can be repeatedly stretched to its full length without affecting spring-back qualities or damaging the neoprene jacket.

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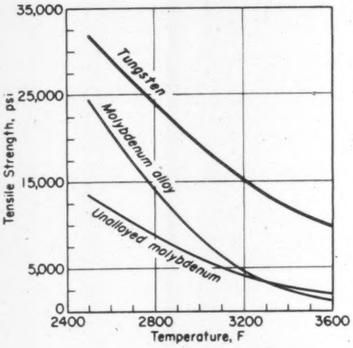


***Short-time tensile strength** of recrystallized tungsten, unalloyed molybdenum and a molybdenum alloy at temperatures from 2500 to 3600 F.*

approximately 14,000 psi at 3000 F and 4200 psi at 3500 F. The strengthening effectiveness of these two alloying elements in molybdenum decreases with increasing temperature.

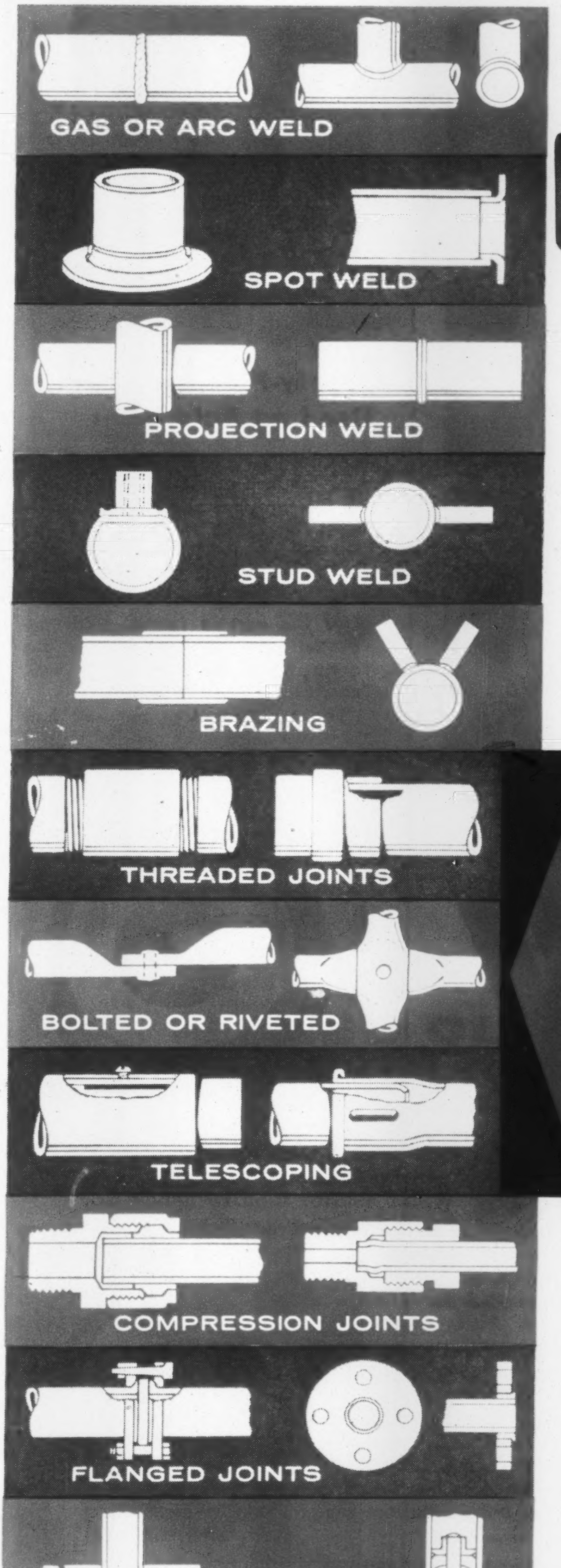
2. Recrystallization at 3800 F reduced the tensile strength of tungsten from 49,000 to about 32,000 psi at 2500 F. Above 3100 F, tungsten recrystallized during testing and had approximately the same strength as that annealed at 3800 F prior to evaluation.

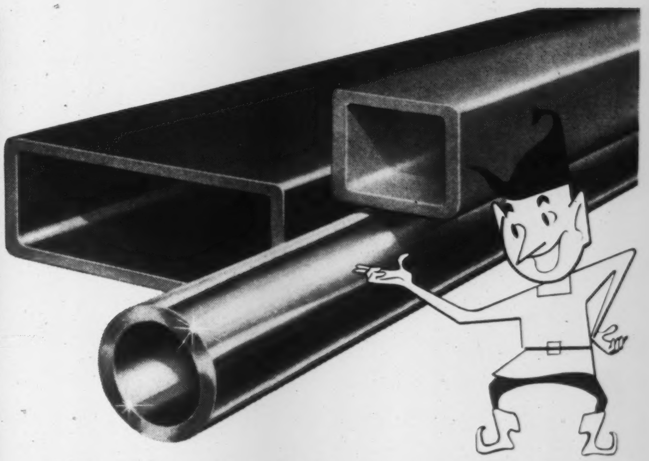
3. The ductility of molybdenum was very high at all test temperatures. In contrast, the ductility of tungsten as measured by elongation and reduction of area at fracture decreased sharply at temperatures above 3120 F. This decrease in ductility was associated with the onset of intergranular cracking.

New Nylon Resin for Complex Extrusions

A new, high melt viscosity, high molecular weight nylon resin can be extruded into shapes and forms which heretofore had to be injection molded or machined.

The resin, introduced recently by Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo. and designated SN 607, can be extruded into film as thin as 0.25 mil. In addition, the resin can be processed into flat film, pipe, tubing, rod and blow moldings. The key to easy processability, says





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LC-594

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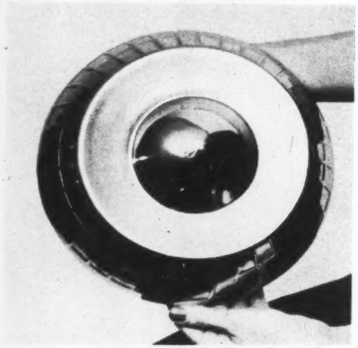
Spencer, is the high melt viscosity of the resin which imparts machine handling characteristics similar to those of polyethylene.

Frosty-Finished Steel Used as Auto Trim

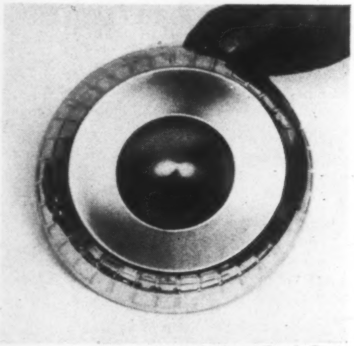
A finish, called Fro-Zon, is now being applied to stainless steel, giving the shiny metal a frosty appearance. Developed by Stamping Service, Inc., 5505 E. Davison Ave., Detroit 12, the new finish is presently being applied to auto trim after the part is formed. The developer also expects to apply the frosty finish to appliances, toys, furniture and cooking utensils.

The company does not say how the technique works, except that it is a "semi-blasting" method which



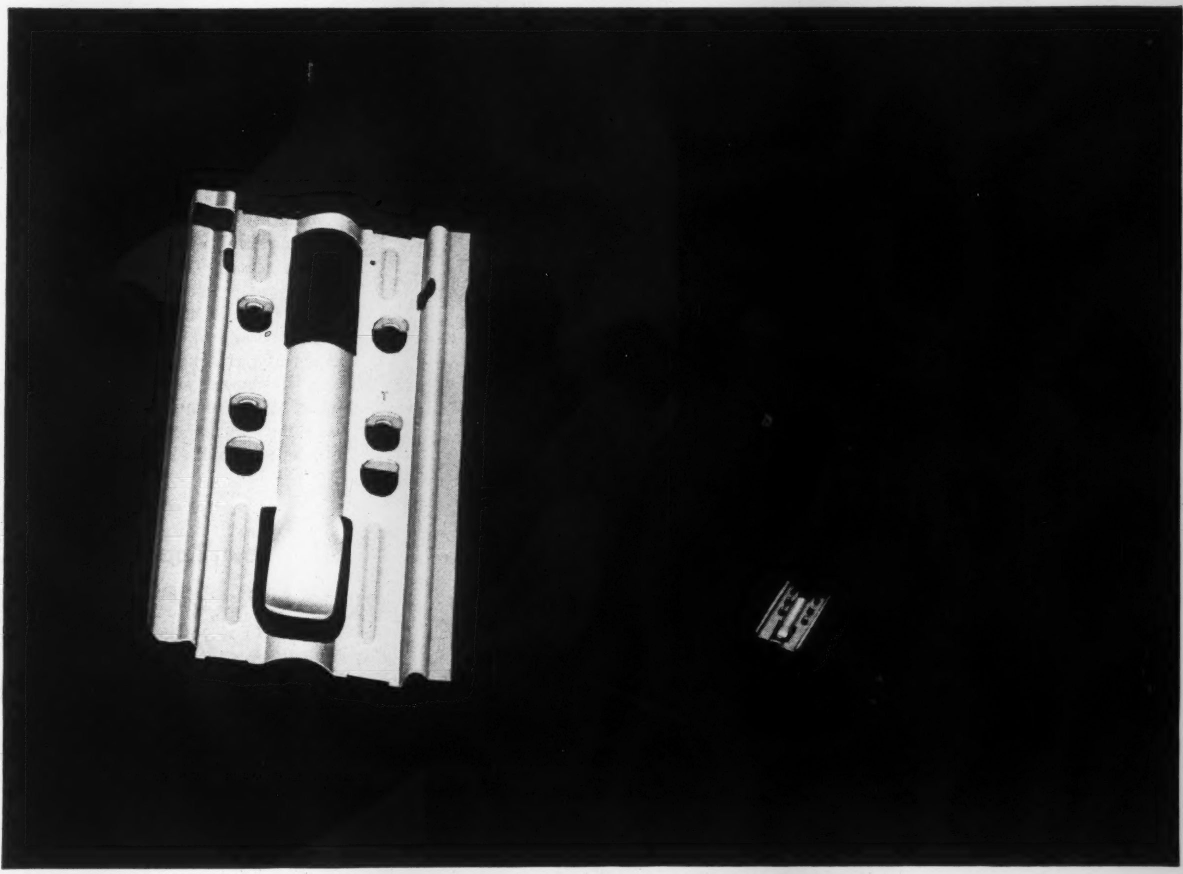
Allegheny Ludlum Steel Corp.

Shiny steel part, *used as trim on automobiles, takes on a . . .*



Allegheny Ludlum Steel Corp.

. . . soft frosted look *after finishing with a new semi-blasting technique called Fro-Zon.*



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SPEED CLIP® costs 50% less, too!

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With this SPEED CLIP, the "self-adjusting" *Divide-a-File* slides more smoothly back and forth in the channel. Locking in the desired position is more positive, too.

This is another example of how Tinnerman Engineering goes far beyond the original fastening idea—how we work with customer engineering departments to produce better working units. And in the above case, a per-part cost reduction of 50% was achieved. In only 4 months, General Fireproofing had saved enough through lower assembly and parts costs to write-off new tooling needed to produce the SPEED CLIP.

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Our specialty is precision molding where close tolerances, intricate shapes, and where thin wall sections are involved. Garlock's United States Gasket Plastics Division has the personnel, the facilities, the unequalled experience in handling tough fluorocarbon plastics.

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gives stainless steel a frosty look by forming tiny mounds on the surface of the metal. The finish is put on very lightly and does not penetrate the surface of the metal.

According to the developer, all kinds of patterns, lettering, and flat and contoured surfaces can be finished by the technique. Neither heat, cold nor weathering seems to have any effect on the surface treatment.

Six New Tapes for Electrical Uses

Five TFE tapes and a polyester-fiberglass tape have recently been introduced for use in electrical and electronic devices.

TFE tapes

Two companies, Continental-Diamond Fibre Corp., Newark, Del., and Joclin Mfg. Co., Wallingford, Conn., have introduced skived and pressure-sensitive TFE tapes.

- *Skived tapes:* Continental-Diamond Fibre Corp.'s tapes are made by skiving TFE billets. The company is offering four grades: ST-X, which has better electrical and physical properties than the other three; ST-C, which is similar to ST-X with slightly reduced properties; ST-1, from which cementable tapes can be made; and ST-2, which is a low cost material. All four tapes are designed primarily for high temperature and high frequency wire and cable insulation.
- *Pressure-sensitive tape:* Joclin Mfg. Co.'s tape, designated Fluorolin 600, is made by fusing together sub-micron-sized particles of TFE to thicknesses from 0.00025 to 0.005 in. A pressure-sensitive silicone adhesive is added to the tape to give it good bondability. The pressure-sensitive TFE tape is recommended for winding coils, bundling and wrapping wires, and insulating generators and transformers.

Polyester-fiberglass tape

Quaker Rubber Div., H. K. Porter Co., Inc., Tacony and Comly Sts., Philadelphia 24 has introduced a polyester-fiberglass tape to which a silicone coating is calendered on one or both sides.

The tape, designated PDG, fits

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FIRST 160,000 PSI LIGHTWEIGHT LOCK NUT 900°F. . . . 80% CHEAPER

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Boots introduces two new hex nuts designed to solve your weight-space requirements by offering up to 75% weight-saving over AN types, 35% space-saving over standard hex nuts . . . with an outstanding stress-temperature performance that actually exceeds all current hex and double hex nuts.

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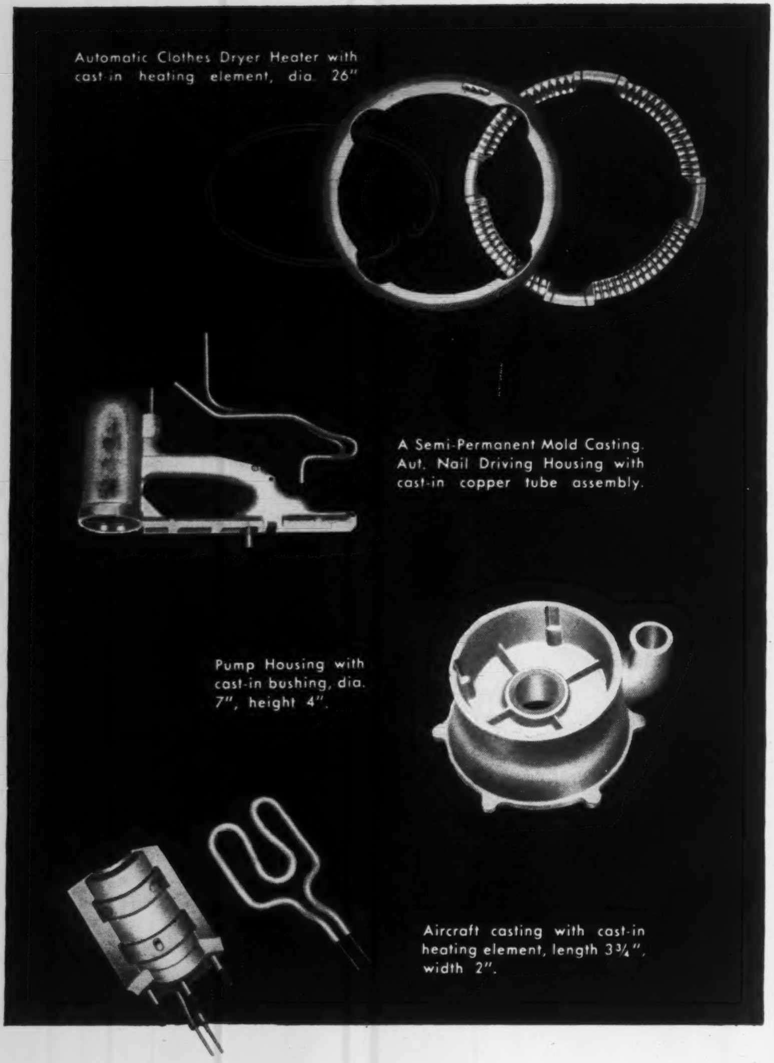

Automatic Clothes Dryer Heater with cast-in heating element, dia. 26"

A Semi-Permanent Mold Casting. Aut. Nail Driving Housing with cast-in copper tube assembly.

Pump Housing with cast-in bushing, dia. 7", height 4".

Aircraft casting with cast-in heating element, length 3¾", width 2".

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Your product design requirements may dictate a light weight, rust-proof casting, tailored to perform with a heating element, bushing or insert. ALUMINUM PERMANENT MOLD casting is the answer, as it is superior to other casting methods for holding and positioning metals selected for integral performances.

Shown here are examples of ALUMINUM PERMANENT MOLD CASTINGS already in use. All requiring the physical advantages of aluminum with bearing metals to resist frictional wear, and conductive metals for varied wattage loads. At EXALCO these are common requirements and create no production challenge to our skilled permanent mold casting engineers.

Your "finished product appearance" may be of primary importance. Our DURAGLAZE was developed by us to provide a finish that cannot crack or chip. It is mechanically applied to any flat or contour surface and assures greater durability than chemical and electrochemical finishes.

Feel free to write us for production procedure and estimates of aluminum castings with or without cast-in features.

Exalco MANUFACTURING CO.
ALUMINUM IN PERMANENT MOLD AND SAND
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snugly on irregular surfaces and keeps its strength under flexing and vibration. It is recommended as an insulation for motor and generator coils, and can also be used in the manufacture of diaphragms and ducting.

Unvulcanized Urethane Resists Tearing, Ozone

A tough, resilient polyurethane elastomer snaps back like rubber yet, unlike rubber, can be used without vulcanization. The unvulcanized material, known as Estane VC, is said to resist tearing and the effects of abrasion, solvents, oil and ozone. The polyurethane elastomer is now available in limited quantities from B. F. Goodrich Chemical Co., Div. of B. F. Goodrich Co., 3135 Euclid Ave., Cleveland 15.

Estane VC has an extensibility of 550% and an average molecular weight of 36,000. For these reasons the polymer is considered to be "virtually crosslinked"; thus the designation VC.

Properties and uses

The first major application for the material will probably be wire and cable jacketing. Other potential uses include: fuel hoses, small bore tubing, belting, coatings for fabrics, sheeting for equipment liners, engine mounts, valve diaphragms, pump components and insulators.

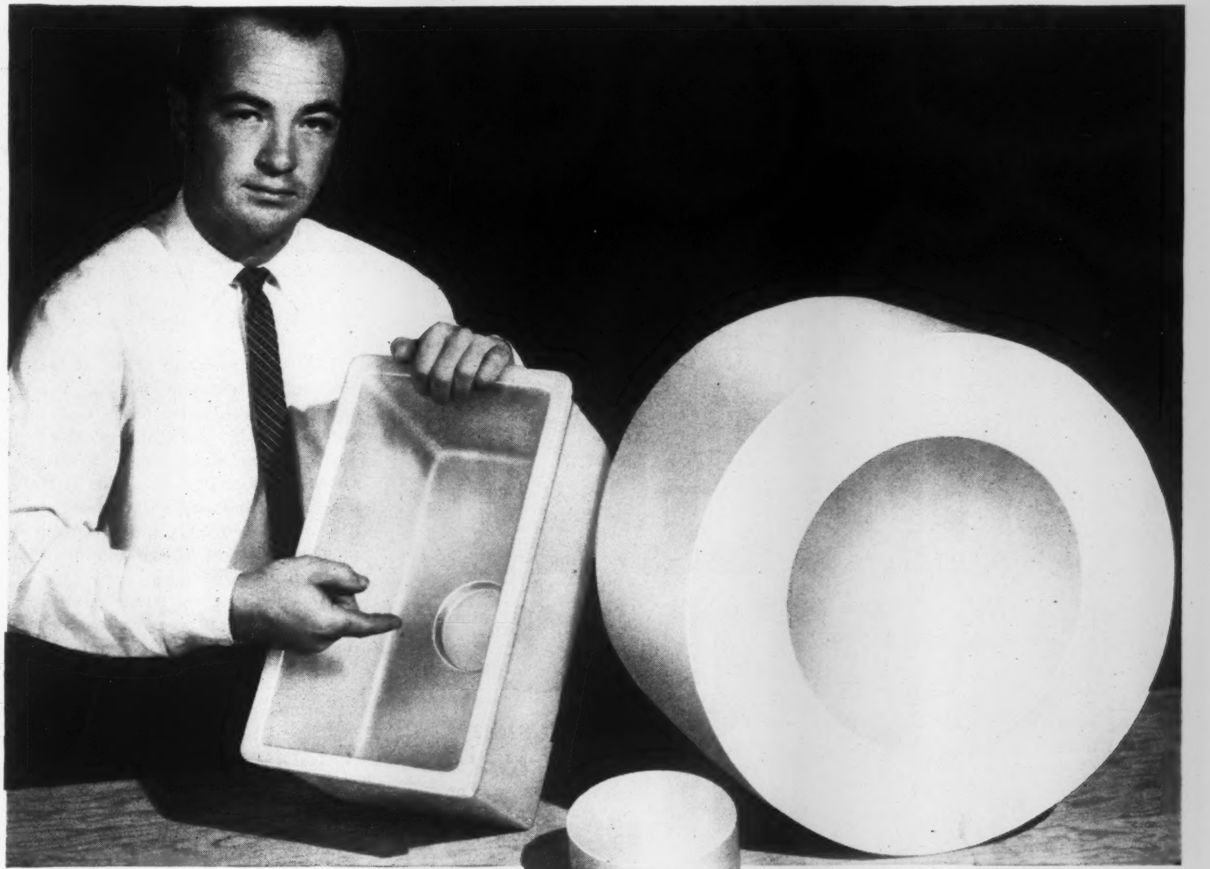
The unvulcanized polyurethane elastomer is little affected by gasoline, hydrocarbon oils, diester oils and water. Moisture content of the polymer is 0.6% at 50% RH (75 F) and 1.6% at 100% RH (75 F).

Estane VC undergoes some degra-

PROPERTIES OF ESTANE VC

Hardness (Shore A)	85
Brittle Point, F	−96
Gehman Low Temperature, F	
T_2	14
T_{10}	−8
T_{100}	−40
Freeze Point, F	−25
Resilience (Yerzley), %	78
Tear Resistance (Graves), lb/0.1 in.	43
Abrasion Resistance (Taber), gm loss[a]	−0.0025
Compression Set, %	
22 Hr at 75 F	39
22 Hr at 160 F	87

[a] CS17 wheel at 5000 rpm.



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ECONOMICAL PRODUCTION . . . UNLIMITED SIZE AND SHAPE

Whether your need is for intricate shapes machine finished to close tolerances, or "slugs" of rough dimensions for further working in your plant, CONNEAUT can produce the parts you require from thermoplastics such as Polyethylene and Nylon.

Compound formulations may be varied to meet specific design requirements. For example, additives such as Elemental Boron, Boron Carbide, Lead Oxide, Cadmium Oxide, etc., can be incorporated into the compound for various nuclear applications.

Typical of the virtually unlimited range of shapes and sizes are the items shown. They may be produced economically in small quantities for experiment purposes or pilot operations. Large-quantity production runs of parts from five pounds to several hundred pounds each, can be molded by Conneaut at substantial savings over production methods requiring costly injection or compression molds. Write for more details, or send prints and details of your requirement for immediate analysis and recommendation. No obligation.

BROCHURE SENT ON REQUEST—

Contains illustrated information on Conneaut's plastic research and development laboratories, and complete plastics production facilities.

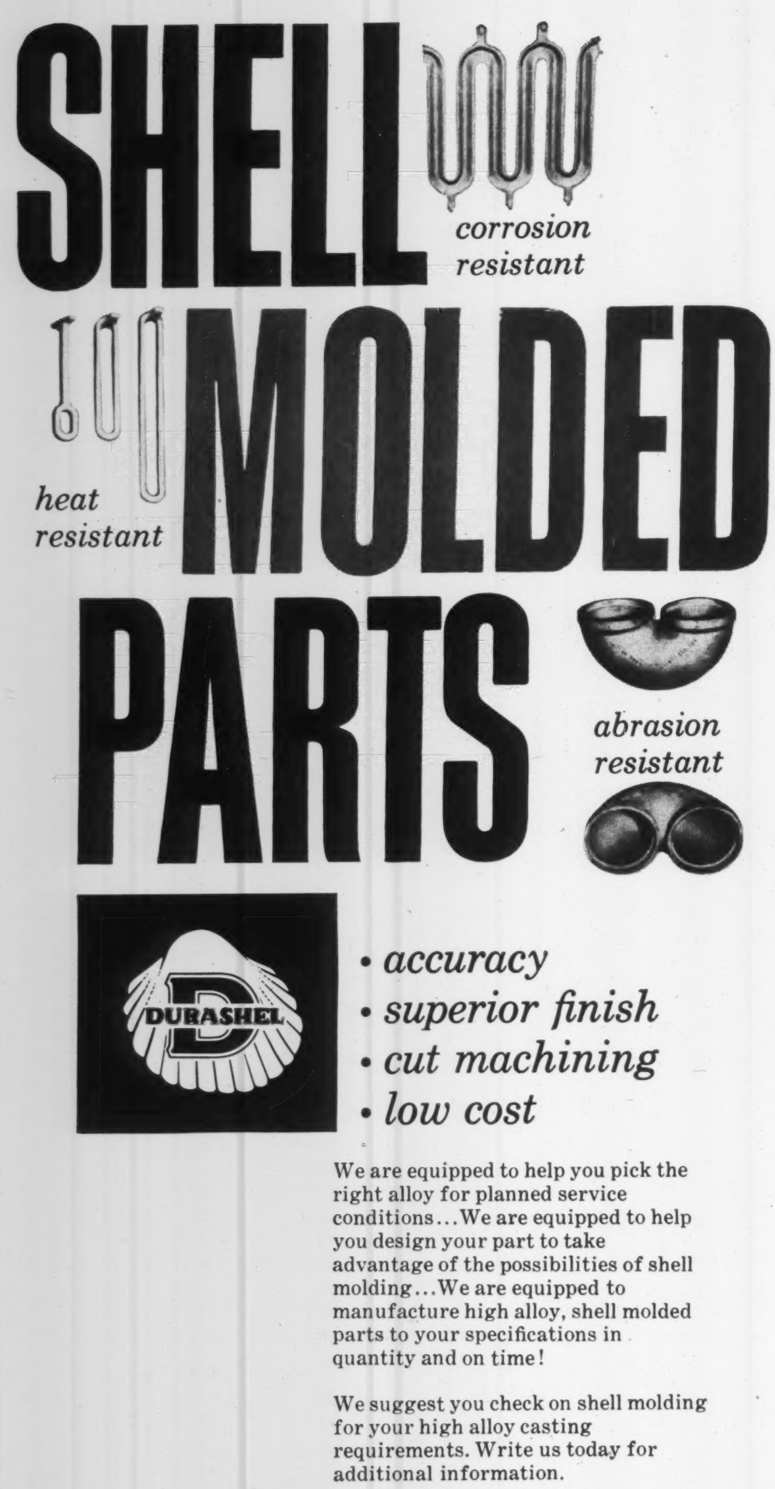
CONNEAUT

RUBBER AND PLASTICS CO.

Conneaut, Ohio **Phone 51-961**

1660-A

For more information, turn to Reader Service card, circle No. 446



- accuracy
- superior finish
- cut machining
- low cost

We are equipped to help you pick the right alloy for planned service conditions...We are equipped to help you design your part to take advantage of the possibilities of shell molding...We are equipped to manufacture high alloy, shell molded parts to your specifications in quantity and on time!

We suggest you check on shell molding for your high alloy casting requirements. Write us today for additional information.

The DURALOY Company
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

For more information, turn to Reader Service card, circle No. 415

dation on exposure to natural and artificial weather conditions. It showed complete resistance to ozone attack after 150-hr exposure to 25 ppm of ozone at 120 F under 20% extension.

The molecules in the virtually crosslinked material can be easily unhooked by solvents. Thus, the elastomer can be used in solution to deposit films which, when dry, have a tensile strength of 7000 to 8000 psi. This film may be redissolved in the specific solvent and redeposited in the form of another film with equal properties.

The new material lends itself well to conventional processing techniques, including milling, calendering, granulation, extrusion and solution.

Titanium Forgings for Aircraft, Turbines

Mallory-Sharon Metals Corp., Niles, Ohio, announced recently that its new heat resistant titanium alloy MST 881 has been successfully made into forgings that meet aircraft industry specifications. (For more detailed information on the alloy, see M/DE, Mar '59, p 144.) The alloy has excellent long-term strength characteristics at temperatures of 1100 F. It has a nominal composition of 8% aluminum, 8% zirconium, and 1% columbium and tantalum combined.

The material is now being evaluated for use in compressor shafts, wheels and blades in Mach 3 jet engines. It is also under evaluation for use in steam turbines operating at 1000 F, high temperature gears, and machine gun poppet valves.

Fibrous Silicone Is Stronger Than Sponge

Fibrous silicone rubber, resembling silicone sponge and foam rubber in appearance, has been developed by Connecticut Hard Rubber Co., 407 East St., New Haven 9, Conn.

Designated Cohrlastic FSR, the material is a mat of silicone rubber oriented in a random manner. This random orientation of fibers is said

Hydraulic Cylinder Manufacturer Specifies

OSTUCO Tubing
FOR AVAILABILITY

Loading a minimum quantity of Ostuco tubing at the Shelby mill — in this instance only 150 feet.

“When you make hydraulic cylinders in 11 bore sizes . . . dozens of different pressure ratings . . . a variety of wall thicknesses and analyses — you've got a man-size tubing inventory problem.

“That's why we switched to Ostuco tubing made to our *exact specifications*. We like its availability in truly *small minimum quantities*. And with its consistently close tolerances, shipment after shipment, Ostuco tubing has *cut our machining time over 50 percent . . .*”

This is an actual case history of a manufacturer with a severe inventory problem. He required special tubing grades in minimum quantities. If you're faced with a similar situation, it's time you contacted your Ohio Seamless representative, listed in the Yellow Pages, or the mill at *Shelby, Ohio — Birthplace of the Seamless Steel Tube Industry in America.*

AA-8843

OSTUCO OSTUCO TUBING

OHIO SEAMLESS TUBE DIVISION

of Copperweld Steel Company • SHELBY, OHIO

Be sure to visit Booth 205
Design Engineering Show
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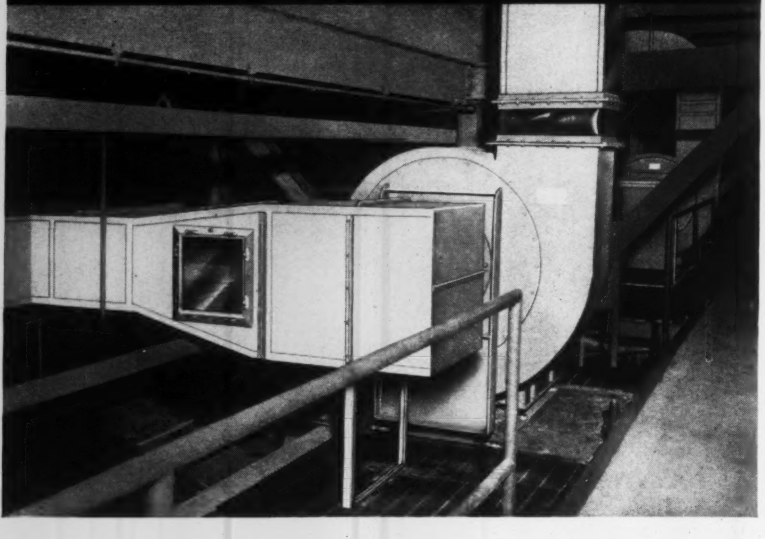
Seamless and Electric Resistance Welded Steel Tubing • Fabricating and Forging

SALES OFFICES: Birmingham, Charlotte, Chicago (Oak Park), Cleveland, Dayton, Denver, Detroit (Huntington Woods), Houston, Los Angeles (Lynwood), Moline, New Orleans (Chalmette), New York, North Kansas City, Philadelphia (Wynnewood), Pittsburgh, Rochester, St. Louis, St. Paul, St. Petersburgh, Salt Lake City, Seattle, Tulsa, Wichita **CANADA:** Railway & Power Engr. Corp., Ltd. **EXPORT:** Copperweld Steel International Company, 225 Broadway, New York 7, New York

For more information, turn to Reader Service card, circle No. 374

problem: **Corrosive Acid Fumes**

solution: **Van-Cor Exhaust Duct System**

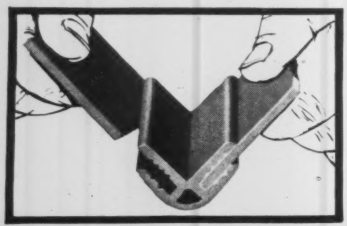


OVER 50,000 SQ. FT. OF VAN-COR SHEET AND JOINING STRIPS remove all acid, plating and cleaning fumes throughout the Allentown (Pa.) Works of Western Electric Co. Corrosion is stopped in its tracks because Van-Cor unplasticized PVC is resistant to scores of acids, alkalies and salts.

Although the contractor was unfamiliar with plastics fabrication, he was able to assemble the components of this system on the job site at a substantial savings over installation of prefabricated components. This savings was made possible through the use of Van-Cor joining strips.

VAN-COR FABRICATIONS, PIPE, FITTINGS, VALVES, CONDUITS offer *you* these advantages:

1. *Resist Corrosion of Industrial Acids & Alkalies*
2. *Light in Weight (½ that of Aluminum)*
3. *Easily Installed; High Tensile Strength; Low Flow Resistance*
4. *Readily Formed, Machined, Threaded and Welded*



Van-Cor 90° and H Joining Strips
The fast, low-cost way
to connect PVC sheet stock.

Write for Catalog and Name of Nearest Distributor

INDUSTRIAL DIVISION OF...
COLONIAL PLASTICS MFG. CO.
Subsidiary of THE VAN DORN IRON WORKS CO.
2685 EAST 79TH STREET CLEVELAND 4, OHIO

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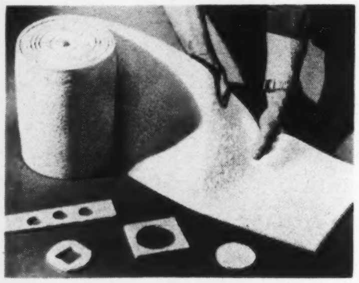


***Tear resistance** of fibrous silicone rubber is much better than that of sponge or foam rubber.*

to produce a product that has higher tensile strength and better tear resistance than silicone sponge and foam. Other characteristics: 1) high permeability, 2) good compression set, and 3) useful temperature range of –65 to 500 F.

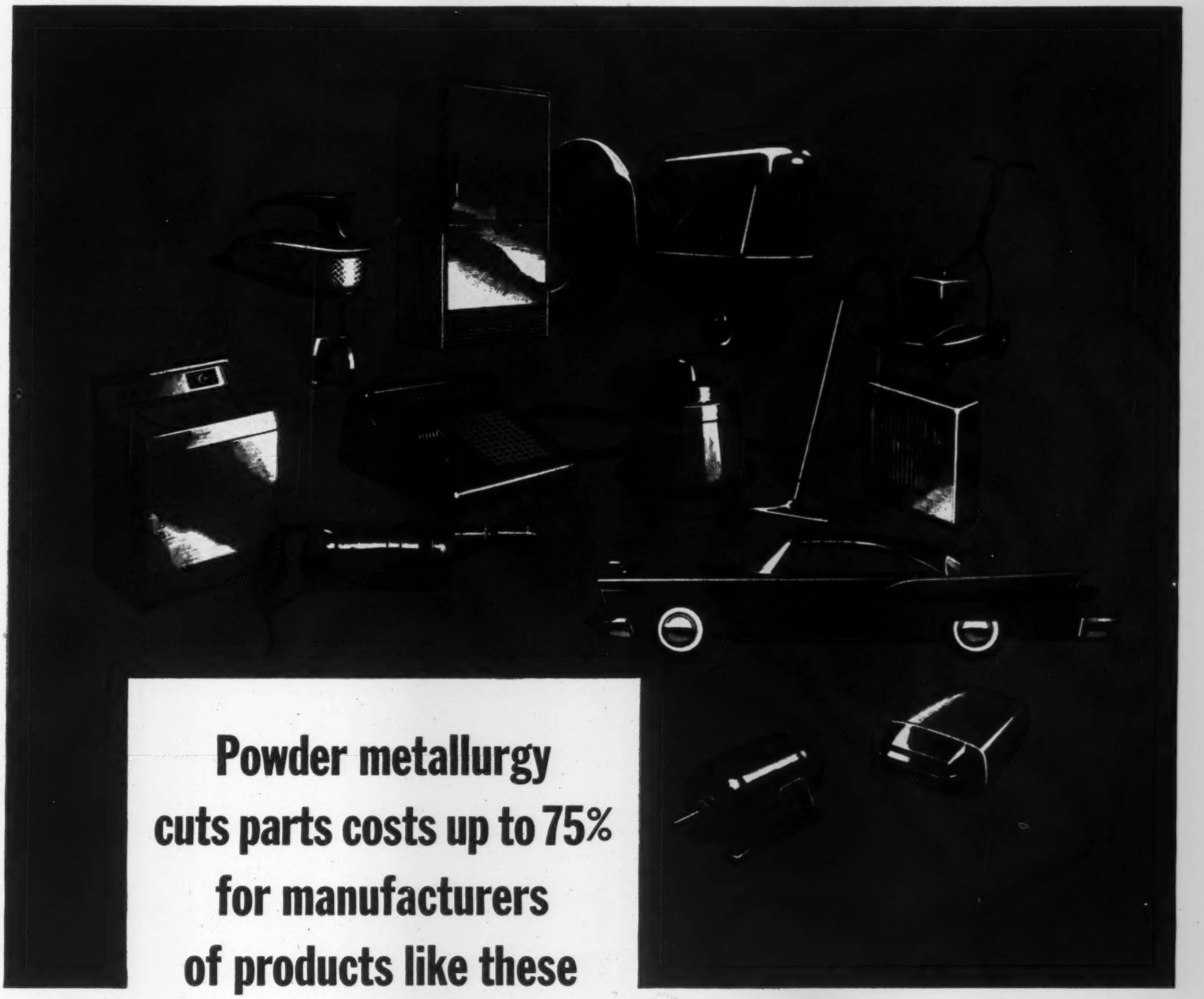
The material is presently available in limited quantities in sheets ¼ in. thick, 9 in. wide, and 6 ft long.

Polyester Resin Withstands 500 F

Commercial availability of a new polyester resin for reinforced plastics parts has been announced by General Electric Co., Chemical Materials Dept., 1211 N. Olive St., P. O. Box 630, Anaheim, Calif. The resin, called AR-1075, is said to produce laminates that will withstand temperatures of 450 F continuously and temperatures of 500 F intermittently. The material is

PROPERTIES OF AR-1075 POLYESTER-GLASS LAMINATE

PHYSICAL PROPERTIES	
Specific Gravity	1.85
Water Absorption (24 hr), %	0.14
Flammability	Self-extinguishing
ORIGINAL MECHANICAL PROPERTIES	
Ten Str, psi	59,000
Flex Str (flatwise), psi	64,700
Compr Str (edgewise), psi	51,000
Barcol Hardness	68
Initial Mod of Elast, psi	3.0 x 10^6
AFTER AGING ½ HR at 160 F	
Flex Str (flatwise), psi	51,400
Initial Mod of Elast, psi	2.3 x 10^6
ELECTRICAL PROPERTIES	
Dielectric Constant	4.1
Loss Factor	0.012

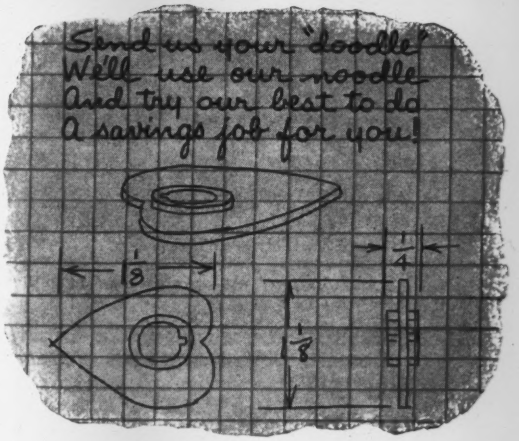


Powder metallurgy cuts parts costs up to 75% for manufacturers of products like these

Why not find out now if powder metallurgy holds the answer to your high parts costs?

Send Glidden a sketch of any part, plus the quantity desired. Glidden, with the help of qualified parts fabricators in your area, will determine, first, whether the part can be made with metal powder. If it can, you will receive cost quotations that may show really worthwhile savings—similar to savings realized by an increasing number of manufacturers who have found that metal powder parts can be mass-produced faster, better, more economically.

As a leading supplier of metal powders, Glidden works closely with parts producers. In this way, several staffs of experienced technicians may be at your disposal—to provide complete technical service and suggest possible design changes that may bring even lower parts costs.



QUALITY Glidden PRODUCTS

RESISTOX METAL POWDERS

The Glidden Company
Chemicals—Pigments—Metals Division
Hammond, Indiana

COPPER POWDER • LEAD POWDER • TIN POWDER • BRASS POWDER • ALLOY POWDER • FILTER POWDER
CUPRIC OXIDE • CUPROUS SULFIDE • CUBOND COPPER BRAZING PASTE • COPPER PIGMENT

For more information, turn to Reader Service card, circle No. 406

STAINLESS
STEEL
STRIP

THROUGH
SUPERB FACILITIES . . .
SUPERB QUALITY

What do Wallingford Steel's new facilities—a new metallurgical laboratory, Sendzimir Mill installations, and automation gaging systems—mean to you, the user?

They mean *better* stainless steel and super metals with uniform quality and gage, lustrous finish, and exceptional resistance to high heat, corrosion and wear. They mean *better* flexibility in the scheduling and delivery of strip to help you schedule *your* production more efficiently.

Our exceptionally rigid quality control—X-ray gaging for strip thickness, sensitive elongation gaging for rolling operations—and laboratory sampling of our strip before shipping, assure you stainless strip which is unsurpassed.

In summary, *the stainless steel strip you need when you need it !*

FACILITIES FOR WIDTHS UP TO 27"—THICKNESSES DOWN TO .001"—EXTREMELY CLOSE TOLERANCES MAINTAINED

Write for complete data.

THE WALLINGFORD STEEL CO.

Progress in Metals for over 37 Years

WALLINGFORD, CONN., U.S.A.

COLD ROLLED STRIP: Super Metals, Stainless, Alloy
WELDED TUBES AND PIPE: Super Metals, Stainless, Alloy

For more information, turn to Reader Service card, circle No. 462

priced at 77¢ per lb in 100-lb lots.

GE says the resin should find use in reinforced plastic radomes, aircraft ducting and missile parts. Flexural strength values in excess of 30,000 psi and compressive strength values of about 20,000 psi have been obtained for the resin after aging 200 hr at 425 F.

The material is easy to mold and can be fabricated with heated matched die molds or by hand layup at room temperature.

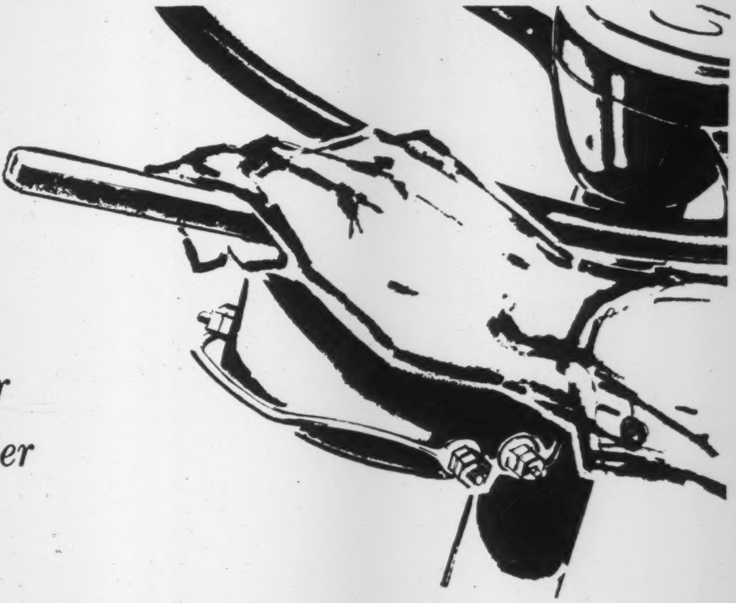
Synthetic Textile Fibers Resist Acids, Alkalis

One new polypropylene and two new polyethylene textile fibers are recent developments of the United States Rubber Co., Royalene Dept., 10 Eagle St., Providence, R. I

All three synthetic fibers have excellent resistance to all but oxidizing acids, and excellent resistance to alkalis. The materials have good

Explosive forming technique—Technicians are getting ready to set off an explosive charge in a new explosive forming device used to produce fuel tanks for the IM-99 Bomarc missile. The fuel tank, made of high strength steel, is welded together, then heat treated. After heat treatment, the tank is placed in a two-piece sizing die and filled with water. A specially mixed explosive charge is lowered into the flooded tank and set off by an electronic detonator. The blast forms the steel tank to close dimensional tolerances. The explosive forming technique was developed by Boeing Airplane Co., Seattle, Wash.

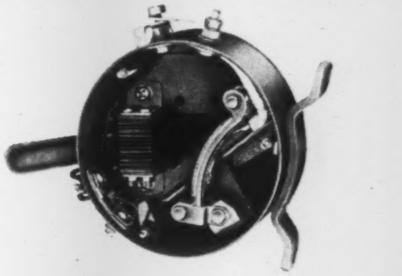
Instantly,
Smoothly,
new "Contact Bronze"
applies graduated power
to heavy-duty trailer
brakes



CONTACT!

COSTS 25% LESS

These contact leaves are stamped and formed from Bridgeport "Contact Bronze" Alloy 92 at a savings of 25%. Its performance-proved spring properties provide part reliability through thousands of cycles.



FORMS EASILY

Warner Electric Brake system for heavy-duty trailer combination is actuated by this controller. This view shows the series of easily formed "Contact Bronze" leaves that transmit power in smoothly graduated steps.

This ingenious electric brake system devised by Warner Electric Brake & Clutch Company gives the driver instantaneous synchronization of all brakes. Through a graduated series of Bridgeport "Contact Bronze" leaves, it lets the driver adjust torque smoothly to suit load and road conditions.

"Contact Bronze" Alloy 92 saves up to 25% on material cost. Its quality and dependability are maintained by the addition of a minute quantity of phosphorus for superior spring properties. It easily withstands difficult forming operations without losing its spring properties.

If you form or stamp contact parts for electrical or electronic equipment, you will want details on "Contact Bronze," as well as Bridgeport's other alloys for the electrical industries. Call your nearby Bridgeport sales office for immediate service or, for samples and a copy of the "Contact Bronze" data sheet, write to Dept. 3503.

Brass Bridgeport Co.

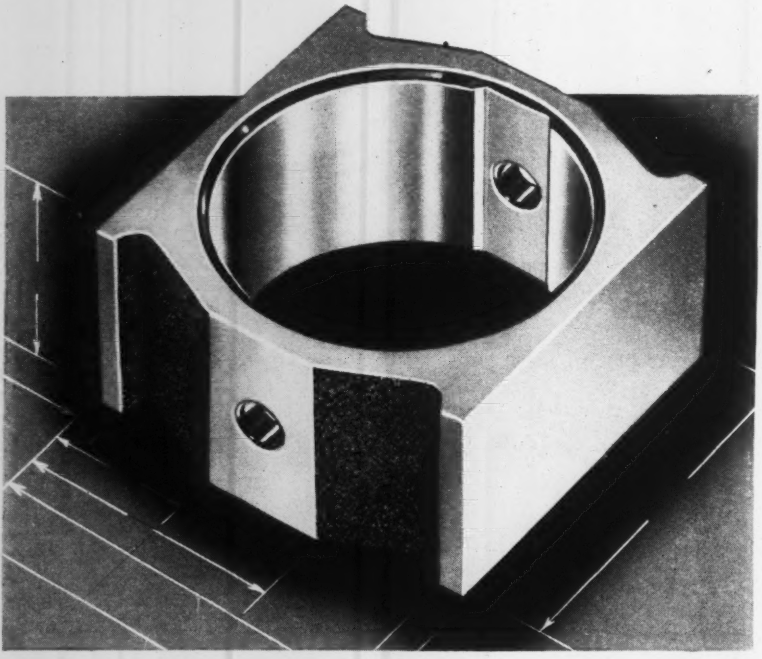
BRIDGEPORT BRASS COMPANY

Bridgeport 2, Conn. • Sales Offices in Principal Cities

*Specialists in Metals from **A**luminum to **Z**irconium*

For more information, turn to Reader Service card, circle No. 412

many difficult requirements...



We illustrate the cast bronze cam block for a hydraulic pump operating the hydraulic lift mechanism on an exceedingly well-known line of farm tractors.

The manufacturer of this equipment has very unusual specifications for this cam block. Its bore has a very fine finish specification. It also must be round and true to size within unusually close limits. In addition, it must be square to the face of the cam block within limits that ordinary methods of manufacture will not attain.

Bunting methods of manufacture result in a part which is completely to the customer's exacting specifications.

For the unusual, as well as the usual, in bearings, bushings, bars, or special parts of cast bronze, sintered metal, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

..*ask or write for your copy of*...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

Bunting®

The Bunting Brass and Bronze Company
Toledo 1, Ohio—EVergreen 2-3451
Branches in Principal Cities

BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF
CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS

For more information, turn to Reader Service card, circle No. 429

PROPERTIES OF SYNTHETIC FIBERS

Type ➡	P	A	N
Tenacity, gm/denier	6	7.1	5.9
Elongation, %	12	13	13
Heat Dist Temp, F	300	260	260
Shrinkage (212 F), %	8	6	6
Brittle Point, F	−40	—	—

resistance to aliphatic hydrocarbons, but swell slightly in aromatic and halogenated hydrocarbons. The fibers have potential use as ropes, filter cloths, decorative screens and novelty fabrics.

Polypropylene fibers: Designated Type P, the polypropylene fibers are said to have a higher heat distortion point, better resilience, and lower density than other available polyethylene fibers.

Polyethylene fibers: Type A is the name given to U. S. Rubber's high density linear polyethylene fiber, and Type N to its high density copolymer polyethylene fiber. Type A fibers have a tenacity of 6.2 gm per denier and Type N fibers have a tenacity of 5.9 gm per denier after 2000-hr exposure in a type XW Weatherometer.

Electrical Insulation Stable up to 1550 F

A machinable electrical insulation made of synthetic mica and glass is dimensionally stable at temperatures up to 1550 F. The material, called Supramica 620, can be machined to tolerances as close as 0.00010 in. because of its fine, uniform texture. It is commercially available from Mycalex Corp. of America, Clifton, N. J.

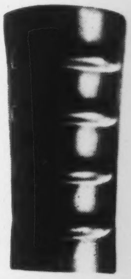
According to the developer, Supramica 620 has heat resistance comparable to that of alumina and steatite ceramics, both of which are relatively difficult to machine. The new material has good radiation resistance, and a thermal expansion

ELECTRICAL PROPERTIES OF SUPRAMICA 620

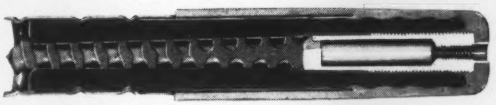
Dielectric Strength, v/mil	250
Arc Resistance, sec	300
Loss Factor (10^6 cps)	0.011

IMPACT PROBLEMS IN 4 DIFFERENT FIELDS SOLVED WITH *SPAULDING* MATERIALS

Railroad Track End Post made of Spaulding Vulcanized Fibre, combining impact strength with dielectric strength.



Hockey Shin Guard made of Spaulding Vulcanized Fibre—impact strength plus versatile forming quality.



Lightning arrestor with Spaulding Vulcanized Fibre Baffle—impact strength plus high dielectric and machining qualities.

Steel Mill Thrust Collar of Spauldite—impact strength plus resistance to wear and pressure.

All four of the objects shown above must stand up to tremendous impact forces. Yet each of them combines impact strength with other unique and varying properties to do the whole job. That's why in each case the manufacturer used a Spaulding basic material.

Contact Spaulding when you have an application that calls for any or all of these properties:

- great mechanical strength
- light weight
- durability
- chemical inertia
- arc resistance
- low moisture absorption
- dielectric strength
- resistance to impact

A factory-trained Spaulding Engineer can help you select the right material and we will produce finished parts to your specifications.

Our 5 Plants and 28 Branch Sales Offices Serve Every Industry
NEMA

SPAULDING FIBRE COMPANY, INC.
310 WHEELER STREET, TONAWANDA, NEW YORK

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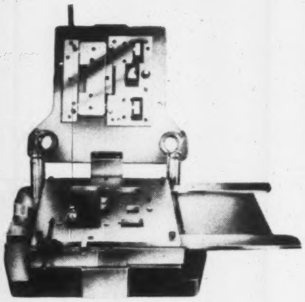


TOOL LIFE INCREASED 30% OR MORE...

...with miller

200-PLUS

PHOSPHOR BRONZE

*A leading manufacturer of wiring device assemblies reports: "Miller 200-PLUS phosphor bronze, with its great formability, has significantly reduced our need for tool sharpening, and all indications point to a greatly increased tool life. In addition, I get a more consistent part, with more uniform shape and springback."

The secret's in the 200% ductility increase of Miller 200-PLUS. Forming ability goes way up . . . tensile strength remains the same! The result is far less abrasion than with other phosphor bronzes in spring temper—and tools that last one-third longer!

*Name and case history on request

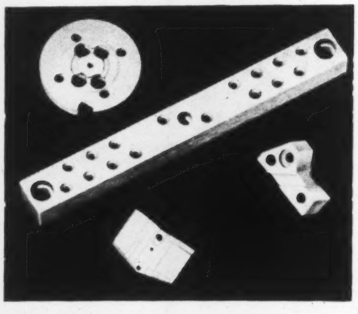
Typical of problem parts that cause abrasion to tool parts is this electric range switch component. Greater formability of 200-PLUS means less abrasion —longer tool life.

ROLLING MILL DIVISION
THE MILLER COMPANY
MERIDEN, CONN.

...WHERE PHOSPHOR BRONZE IS THE MAIN LINE—NOT A SIDELINE

For more information, turn to Reader Service card, circle No. 489

What's new IN MATERIALS



***Typical parts** made of a machinable electrical insulation.*

equal to that of stainless steel. It does not carbonize.

Among the possible uses of the synthetic mica-glass insulation are switchboard panels, heating devices, relay contact supports, brush holders and radio transmitter parts.

Vinyl Sheeting Has High Impact Strength

Three new vinyl sheeting materials are said to have greater impact strength than conventional vinyl sheeting materials. They are also said to have greater light stability and better heat resistance.

All three materials are now commercially available from Union Carbide Plastics Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 31. They are supplied as sheets in thicknesses from 0.007 to 0.030 in., and in widths up to 51½ in.

VCAB—3603

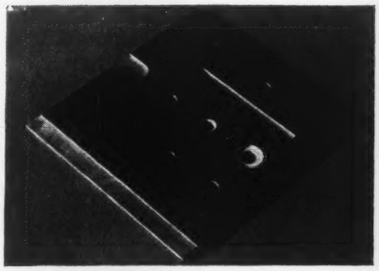
The first of these materials, VCAB-3603, was developed for products subjected to continuous flexing and handling, such as book bindings and playing cards. The material, because of its good light stability and

PROPERTIES OF VINYL SHEETING

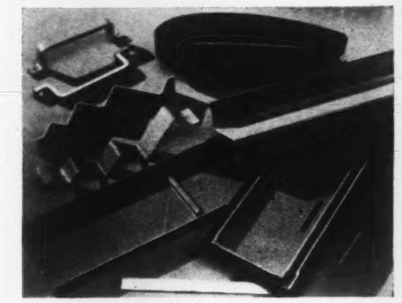
Type ➡	3603	3604	3606
Specific Gravity	1.44	1.30	1.30
Water Absorption (24 hr), %	0.06	0.07	0.09
Ten Str, psi	7000	7500	8000
Flex Str, psi	10,500	10,000	11,000
Mod of Elast, psi			
Tension	35×10^6	34×10^6	38×10^6
Flexure	38×10^6	38×10^6	40×10^6

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Fire-retardant electrical laminates**
- **Plastic for wire-spring relay**



Plain . . .



or fancy

This electrical laminate deserves more than a casual look, if only because there are so many things you can do with it.

Made of glass-reinforced polyester, it comes in sheets or molded shapes that embody three useful attributes. First, they are strong enough to play a structural role in heavy-duty electrical equipment. Second, they retard fire. Third, their excellent electrical properties change but little at 100% relative humidity.

The shapes you see here are made with Hetron® polyester resin by Fiber Glass Industries, Inc., and are inherently flame-retardant. Hetron burns only in the immediate vicinity of an arc or hot flame, and quickly extinguishes itself when the heat source is removed. Thus in case of a burnout, damage is usually confined to a small area, with minimum effect on mechanical strength of the material.

Generally, Hetron laminates exhibit very low loss factor over a wide range of frequencies. Dielectric constant, for a ⅛-inch glass-mat laminate containing 35% glass, hovers as low as 4.25. Arc resistance of such a laminate is on the order of 110 seconds.

Do these traits suggest a way to achieve long life in equipment handling medium and high voltages? We'll gladly send you the complete data file on Hetron resins, and names of skilled fabricators who can supply laminates and molded shapes to match your ideas.

Building a better relay

Often it isn't enough to design a product. You may also have to find a way to make it.

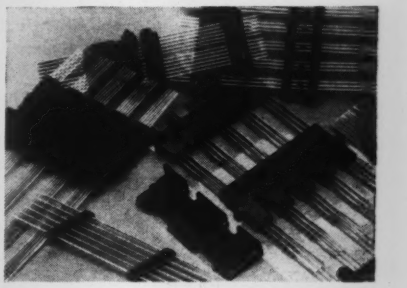
Such was the case when engineers at Bell Telephone Laboratories developed for Western Electric Co. a new relay, basic component of telephone switching equipment.

In one swoop the new design—called the wire-spring relay—promised to reduce manufacturing and maintenance costs, work better, and last longer than its predecessor. However, this involved something that had never been done—molding straight wires into small plastic blocks automatically.

Before it could be done, Western Electric engineers had to:

1. devise a way to straighten small-diameter spooled wire;
2. feed the straightened wire into a mold in precisely spaced groupings;
3. embed the wires without shift in a molding compound that would insulate them and hold them securely for a relay lifetime of one billion operations or more.

Early in the game it became apparent that this was a job for phenolics. A major requirement was fast cure. Another was batch-to-batch consistency of the molding material. At fast cure speeds, a 10% variation in curing time can mean as little as 1.2 seconds' leeway between a reject and a good piece.



Volume resistivity was important. Could a Durez material handle the job?

Yes, one could. The wire-spring subassemblies you see here are made with it. They are being produced at low cost to the required accuracy in fully automatic molding machines. They prove the ingenuity of the men who developed this new concept in telephone switching—and the versatility that *you* command when you design with Durez materials.

To get a better idea of how far this versatility goes, check the coupon for more information. Booklets are available describing a range of properties you can get from typical Durez materials; give helpful suggestions on where to use them.

For more information on Durez materials mentioned above, check here:

☐ Data on Hetron, including fabricator lists (50-A)
☐ Durez molding compounds (14 page booklet)
☐ General information on Durez Products (Bulletin 400)

Clip and mail to us with your name, title, company address. *(When requesting samples, please use business letterhead.)*

DUREZ PLASTICS DIVISION
1405 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER
CHEMICALS
PLASTICS

For more information, turn to Reader Service card, circle No. 433

How
FELT
BY FELTERS
Can Improve Product
SEALING and
LUBRICATION

DuFelt is a laminated combination of Felters' felt and Hycar; and is recommended for sealing of lighter oils when no head exists. Seals and lubricates at the same time; and offers improvements over other materials.

Felt is an ideal wicking and lubricating material which can be designed into special assemblies like this distributor cam shown here. Lubrication is constant, wear reduced, and felt can be shaped to cover all required areas.

Lifetime bearing lubrication is now possible by selection of correct SAE grade, and designing into sealed bearing. Felt filters out contamination and works as combined reservoir and wick, directing oil flow to required areas.

Mechanical felt seals permit a close seal without undue pressure. Felt can be waterproofed and provides superior grease and oil retaining and dust, dirt and grit exclusion.

To help you get the most out of FELT, send for the Felters' Design Book. Write, today.

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heat resistance, is also suited for lamp shades, luminous ceilings and other types of light diffusers.

Sheeting made from VCAB-3603 has an Izod impact strength of 15 ft-lb per in., compared to 0.5-0.8 for conventional rigid vinyl materials.

VCAB-3604, 3606

The other grades, VCAB-3604 and 3606, are inert to chemicals, noninflammable, dimensionally stable and odorless. VCAB-3604 has an Izod impact strength of 15 ft-lb per in., and is recommended for lamp shades and displays. VCAB-3606 has good heat resistance, and is recommended for luminous ceilings and other types of light diffusers.

Brazing Filler Metals for High Temperatures

New brazing filler metals for high temperature service were discussed by A. M. Setapen of Handy & Harman at the Midwest Welding Conference held recently in Chicago. Five developments of particular interest are:

1. Silver-lithium alloys

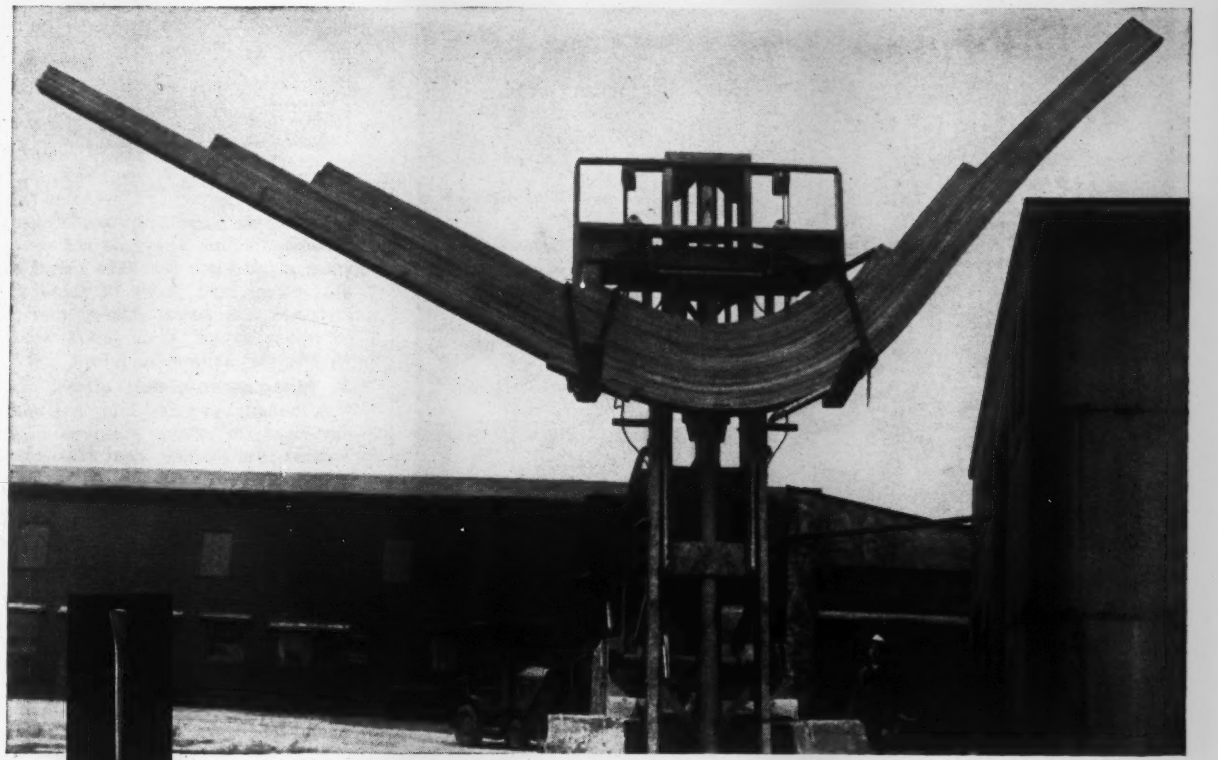
Recent research shows that the addition of a small percentage of lithium to standard silver brazing alloys markedly improves their fluidity and wetting ability. These silver-base lithium alloys are particularly useful for brazing stainless steel without the use of a flux at 1600 F.

Another development is a sterling silver-base lithium alloy for brazing honeycomb panels made of 17-7 PH stainless steel. Flow temperature of the brazing alloy corresponds to the heat treatment temperature for 17-7 PH stainless steel. Joints made with the alloy retain a tensile strength of about 35,000 to 40,000 psi at 900 F.

Still another development discussed by Setapen is a silver-lithium binary alloy containing 2 to 3% lithium. This alloy has shown considerable promise for brazing titanium and its alloys.

2. Silver-palladium alloys

Palladium additions to silver brazing alloys increase melting temperature, strength, and the ability of the filler metal to wet iron and nickel-



from paddles...to gunboat stems...

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The armed forces' solid wood life raft paddles often shattered when dropped from a plane, or splintered when used to "pry" a landing craft onto a beach. Then Gamble Brothers developed a paddle with a shatterproof laminated blade and a dense hardwood handle. Result: a stronger, lighter paddle made with less waste of wood.

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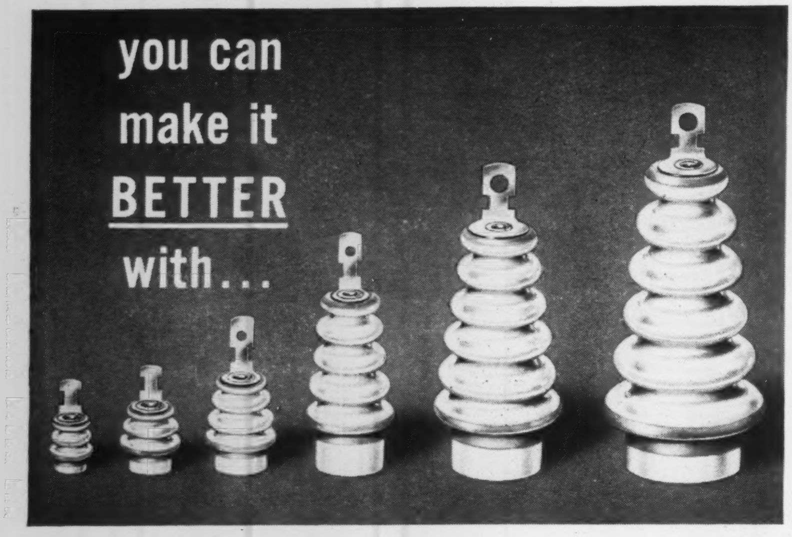
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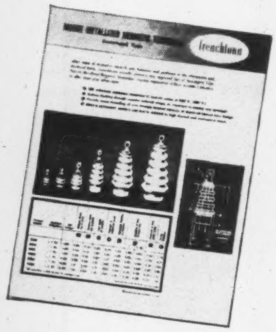

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base alloys, according to Setapen. Silver-palladium alloys do not penetrate or dissolve the base metal to any extent, and joints of these alloys are less susceptible to crevice corrosion attack than joints made with silver-manganese alloys.

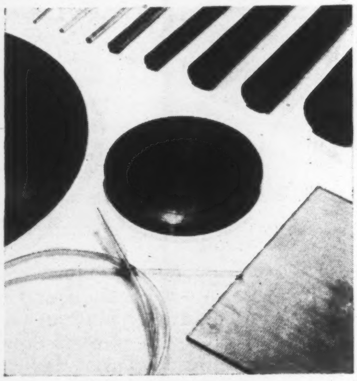
3. Manganese-nickel alloys

A manganese-nickel alloy has been developed for joining stainless steel, Inconel and other heat resistant alloys. It retains much of its high joint strength (55,000 to 65,000 psi) at high temperatures, and has better oxidation resistance than silver-copper-lithium or silver-manganese alloys.

The alloy has much less tendency to dissolve or penetrate the base metal than high nickel brazing alloys. The manganese-nickel brazing alloy has potential use for brazing heat exchangers, rocket motor parts, clad metals and turbine blades.

4. Nickel-silicon-boron alloys

Nickel-silicon-boron brazing alloys keep their strength and hardness at



Tough plastics parts—Rod, tubing, sheet and disks shown here are made of GE's Lexan polycarbonate resin. One of the outstanding features of this relatively new resin is its toughness. (For more detailed information on polycarbonate resin, see M/DE, Dec '58, p 123.) The polycarbonate shapes, called Polypenco, are now commercially available from Polymer Corp. of Pa., 2140 Fairmont Ave., Reading, Pa. Rod is supplied in diameters from ½ to 4 in., and disks from 6 to 18 in. Sheet is supplied in thicknesses from ¼ to 1½ in.

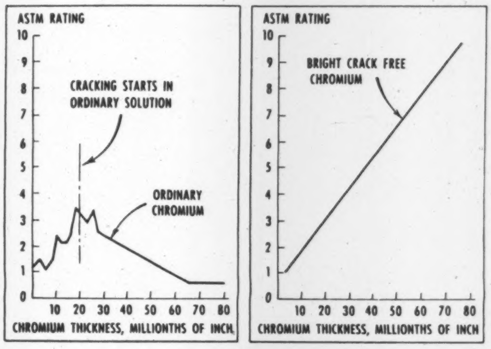
News about COATINGS FOR METALS

from Metal & Thermit Corporation

Thicker chromium plate increases corrosion protection

Thicker chromium in general, and Unichrome SRHS® and Crack-Free deposits especially, are doing more to increase protection against corrosion than any other change in decorative chromium plating in the past 25 years. Latest research demonstrates this.

As far back as 1928, it was shown that ordinary chromium plate soon reaches a critical thickness. (See graph A.) At a thickness of approximately .020 mils, the chromium cracks microscopically. Through these openings, corrosives can reach the undercoatings, and ultimately attack the base metal, ruining the appearance and function of the plated part.



Graph A. Effect of increasing thickness of ordinary chromium on salt spray resistance . . . from Baker & Pinner data, SAE 1928. **Graph B.** Crack-Free Chromium ASTM corrosion ratings based on accelerated acetic acid salt spray tests.

Note, however, that before cracking commences, corrosion resistance *does* build up as the number of pores in the plate are reduced by the thicker deposit. Depending on undercoats, the effect of cracking can be modified.

DUCTILE CHROMIUM DOESN'T CRACK

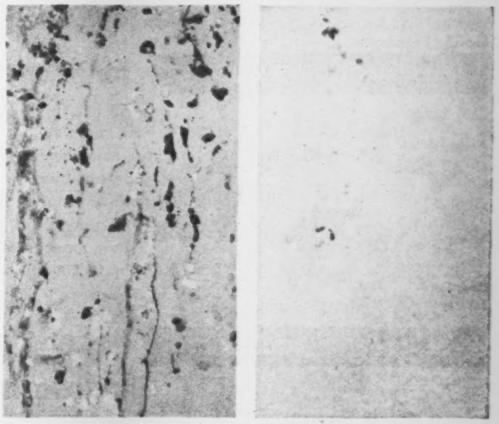
But see what happens in the case of Unichrome Bright Crack-Free Chromium. (Graph B.) An innovation in plating, it plates as thick as desired for practical purposes – entirely without cracks – and, as thickness increases, corrosion-admitting pores are eliminated. Protection keeps rising.

BETTER PROTECTION IN RECESSES

In the past, corrosion usually appeared in recessed areas of parts where little or no chromium could be plated to protect the base metal. This problem, too, is solved by Unichrome Bright Crack-Free Chromium which gives much better coverage and throwing power than previous processes.

LOW COST

The corrosion protection of decorative chromium can be improved several ways. Unichrome Crack-Free Chromium can be used alone or in combination with other fast plating SRHS chromium processes. Combination of chromium deposits, impossible from a practical standpoint for 25 years, is now done commercially with SRHS and Crack-Free Chromium, thereby eliminating need for new, larger tanks and saving thousands of equipment dollars.



Effect of thickness of CRACK-FREE Chromium over thin undercoatings (0.4 mil Nickel on steel) after 48 hours CASS test. Left – 0.015 mil Chromium; right – 0.045 mil Chromium.

A technical paper, "Thicker Decorative Chromium for Better Corrosion Resistance" gives more details. Write for your copy. METAL & THERMIT Corporation, Rahway, New Jersey.

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temperatures up to 1800 F. However, they do attack many base metals by intergranular penetration. These new alloys have potential use for brazing 4130 chromium-molybdenum alloys at 2100 F and stainless steels at 2100 F.

5. Gold alloys

Setapen says gold brazing alloys are particularly useful in situations where intergranular penetration of the base metal cannot be tolerated, and where high strength and excellent oxidation resistance are required near 1600 F. The gold alloys have lower hardness, better ductility and less tendency toward intergranular penetration than the high nickel alloys.

Joints of gold alloys between Inconel and stainless steel were not adversely affected after exposure to air at 1600 F for 88 hr. The joints were made by brazing in a helium atmosphere at 1900 F without using a flux.

Reinforced Plastics at 3,000 to 25,000 F

How good are reinforced plastics at extremely high temperatures? What are the effects of stress concentrations on the strength of reinforced plastics laminates? How good are synthetic fiber fabrics as reinforcements for polyester resin laminates?

The answers to these and other questions were given by various scientists and engineers in papers presented before the 14th annual

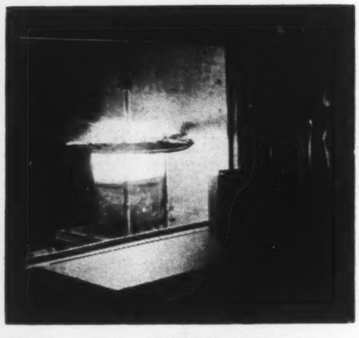

Fig 1—*Water-stabilized plasma arc is used to test reinforced plastics at temperatures up to 25,000 F.*

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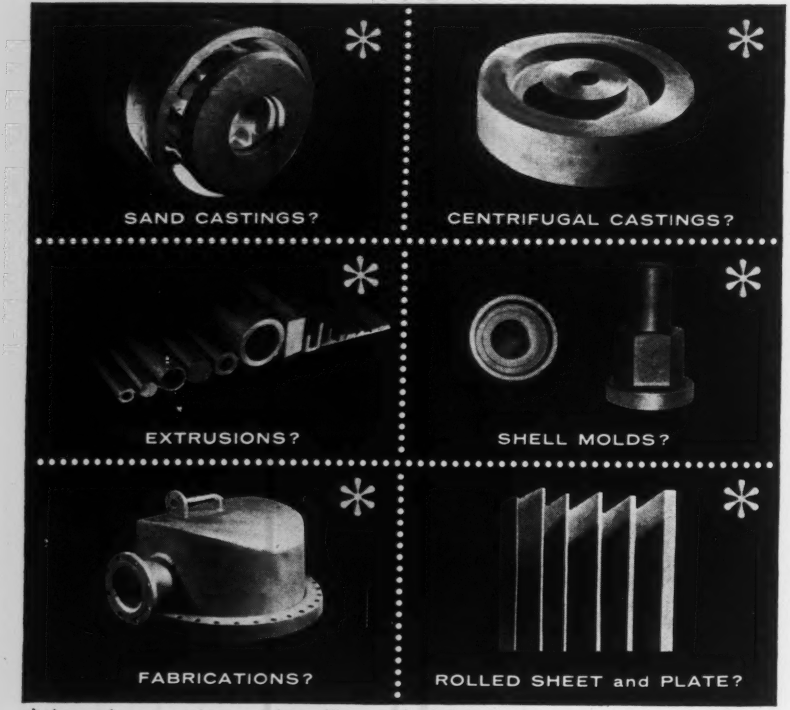

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technical conference of the Reinforced Plastics Div., Society of the Plastics Industry held recently in Chicago.

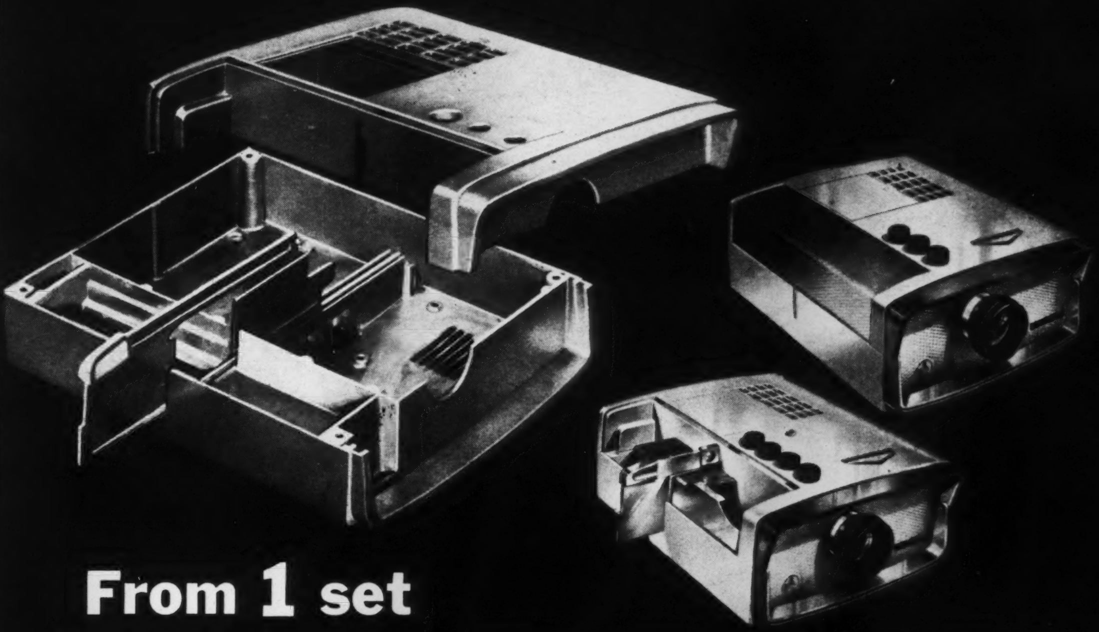
1. Plastics at high temperatures

The fact that certain reinforced plastics are superior to metals and refractory ceramics at temperatures from 3000 to 25,000 F was reported in a recent article appearing in this magazine (see M/DE, June '58, p 100). Some new quantitative data establishing correlations between materials and temperatures were presented in a paper by I. J. Gruntfest, L. H. Shenker and V. N. Saffire of General Electric's Missile and Space Vehicle Dept.

The data resulted from studies of the erosion resistance and surface characteristics of phenolic resins reinforced with nylon, 96% silica glass and conventional glass fibers. All laminates were exposed for short periods of time to temperatures up to 25,000 F in a water-stabilized plasma arc (see Fig 1).

The results confirmed data presented in the June '58 article, i.e., phenolic resins with organic reinforcements such as nylon or acrylic fiber seem to provide the best results at the extremely high temperatures (12,000 to 22,000 F). In glass-phenolic compositions, the lower the glass content the lower the erosion rate. In the lower temperature range (4000 to 5400 F), phenolics reinforced with high silica glass fibers and asbestos provide lower erosion rates in some cases than phenolics reinforced with organic fibers. Also, the higher glass content materials are generally better than those with lower glass content; evidently, at these temperatures the high silica glass "sweats" out and coats the surface with silica, increasing its thermal insulating efficiency.

Examination of the damaged surfaces of the three reinforced phenolics after exposure to high temperatures revealed an interesting relationship among composition, exposure conditions and nature of the surface. The surface of the nylon-phenolic resin after exposure to 24,000 F consisted of a coke-like structure with a network of voids corresponding to the original nylon



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As you can see, these aluminum die castings are intricate. All the necessary slots, channels, pins, gratings, bosses, holes, compartments, handle holes and various recesses are incorporated into the shells so that simple, rapid assembly and minimum finishing operations of the final product result.

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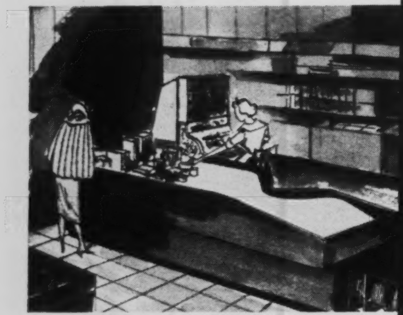
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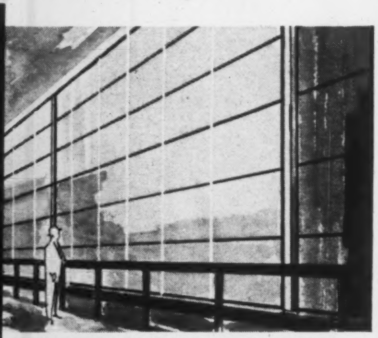
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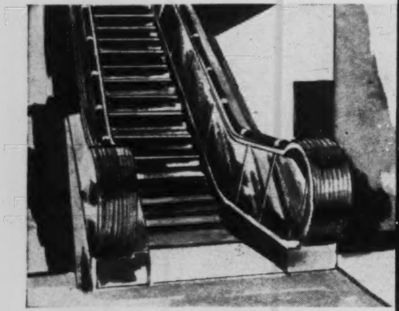
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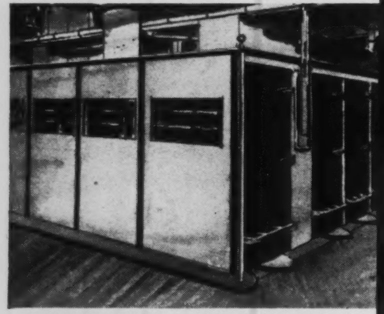
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TABLE 1—TENSILE STRENGTH OF LAMINATES WITH HOLES

Hole Dia, in. ↓	Width, in.	
	0.143	0.250
1/16	38,500	—
1/8	37,700	35,400
1/4	30,600	30,100
1/2	27,100	30,000
1	—	21,700

fibers. The surfaces of silica glass-phenolic and fiberglass-phenolic resins after exposure to 24,000 F were similar in appearance to sandblasted wood. This sandblasted surface effect was observed in high resin content, inorganic-reinforced specimens after exposure to temperatures from 10,300 F to 24,000 F.

Examination of cross sections of all specimens indicated that thermal damage occurred in three distinct stages: 1) ablated (removal of material from the surface of the sample); 2) carbonized; and 3) crazed. The depth of carbonization varied with temperature and resin content in the inorganic-reinforced phenolics. The organic-reinforced phenolic resin showed little change in depth of carbonization over a wide range of temperatures and resin contents.

2. Strength of laminates

When designing a reinforced plastics structure it is important to consider the notch sensitivity of the material used. Eric L. Strauss of Martin Co. presented interesting new data on the effects of plain, countersunk, and countersunk and

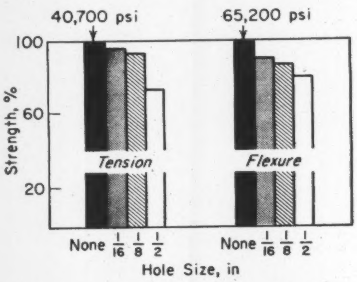

Fig 2—*Effect of various size holes on strength of laminates expressed as percent of the strength of a sample containing no holes.*

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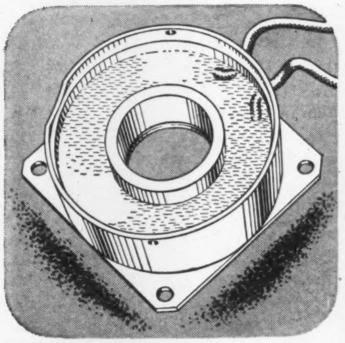
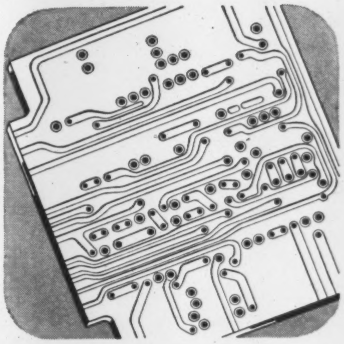
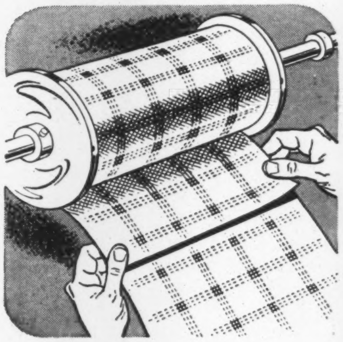


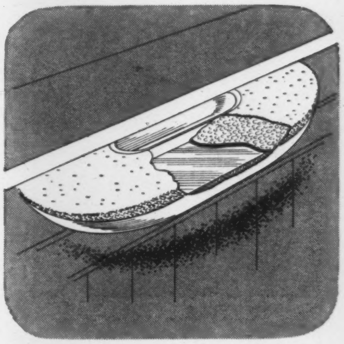
Casting compound for electrical applications



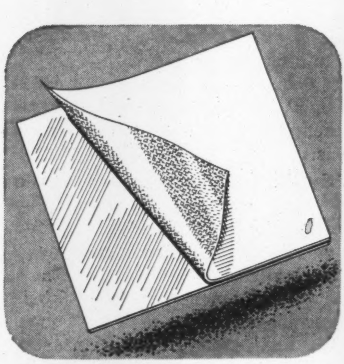
Bonding printed circuits



Bonding textile to textile



Bonding synthetic foam to metal in auto armrest



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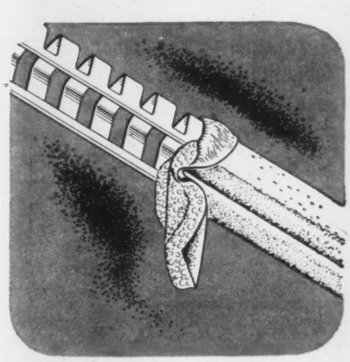

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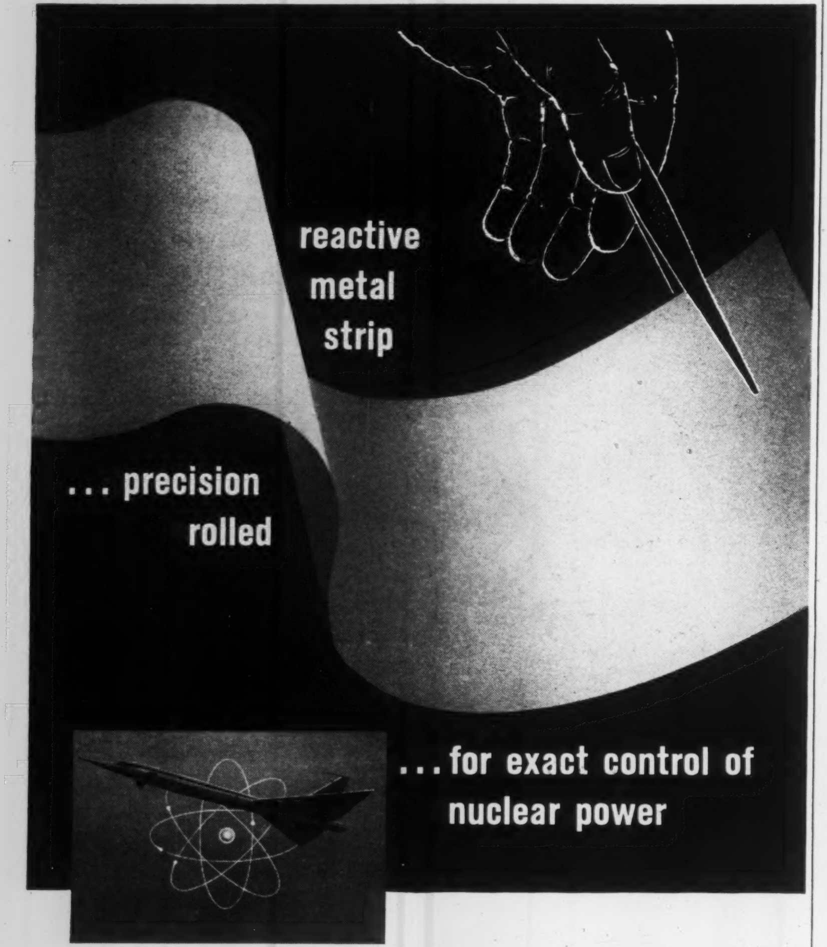

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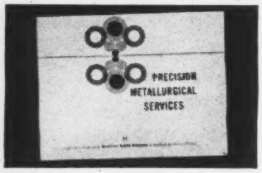

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riveted holes on the tensile, flexural and compressive strengths of glass fabric-reinforced polyester laminates. Table 1 shows the tensile strength of laminates containing different-sized holes: hole diameters ranged from 5 to 58% of specimen width. The tests showed that:

1. Stress concentrations in reinforced plastics induce premature failures not only after numerous load cycles but also during application of a steady load.
2. Tensile strength loss in specimens containing different-shaped and different-sized holes is most pronounced, whereas flexural strength loss is least pronounced.
3. The strength of specimens containing different-sized holes decreases with increasing hole diameter (see Fig 2).
4. Stress concentrations in reinforced plastics laminates produce failures at exceedingly low stress levels. For example, a 4-in. wide specimen containing a 1-in. dia hole failed in tension at 21,700 psi (normal tensile strength is 40,700 psi).
5. Specimens containing multiple holes fail at lower stress levels than specimens containing a single hole.
6. The strength of specimens containing countersunk holes is approximately 5% less than for specimens containing drilled holes.
7. Semicircular notches and holes of equal radii produce similar stress concentration effects in the specimens.

3. Synthetic fiber reinforcements

Results of tests performed by Walter L. Park of Puget Sound Naval Shipyard indicate that polyester laminates reinforced with a continuous-filament Dacron fabric are superior in strength to Dynel, Orlon and spun Dacron-reinforced laminates, and are considerably above the minimum strength requirements for Grade 4 (MIL-P-17549B)

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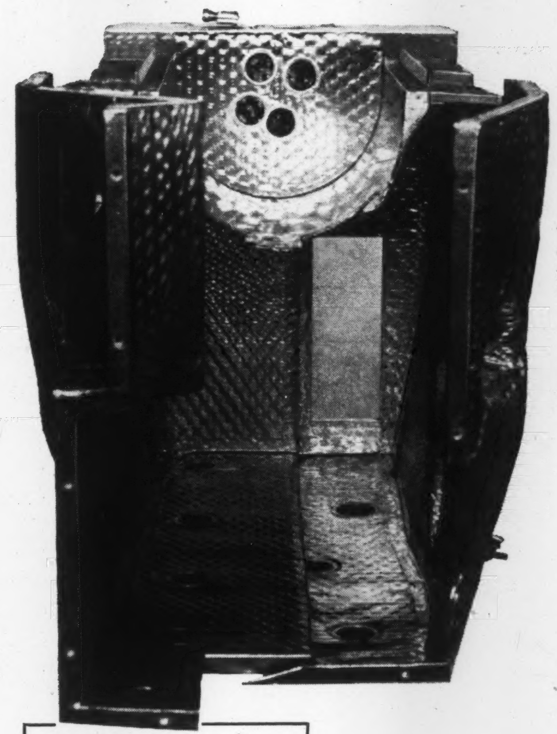

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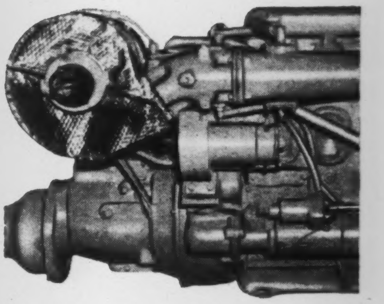

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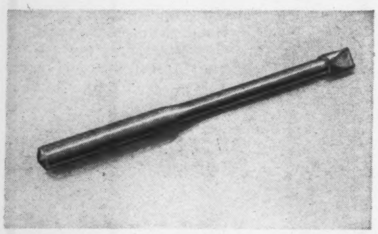
NEWS
from Torrington on
SMALL PRECISION
METAL PARTS

Ordinarily, one would not think of "custom manufacture" and "mass production" in the same breath. Except at Torrington's Specialties Division, where the production of tremendous varieties and quantities of small metal parts of exceptional precision and uniformity is a day-to-day occurrence.

A good example is the valve stem we make for a leading pump manufacturer. Operations include turning, threading, slotting and tempering. Nothing unusual about that, except that Torrington can do it to such precision that the specified finish of 4 to 6 micro-inches is achieved without grinding. This saves our time—and our customer's money, yet every part is produced to perfection.

Another interesting case is an insulated contact pin. It is driven into



wood to check moisture content by electrical conductivity. The reduced center section is insulated. The shank must be accurate to ±.0005", and the diameter of the tapered neck to +.005", -.000". Torrington's engineers devised a way to back-swage the neck to required taper and trim square between head and reduced section *automatically.*

The manufacture of such parts as these, in the tremendous quantities required of us every day, demands highly specialized engineering skills. To serve you most efficiently, our Specialties Division maintains a separate engineering department. Staffed with engineers who have wide experience in precision metalworking, the department can help you with any engineering problems that might arise

in the manufacture of your special metal parts. For prompt service, just circle our number on the reply card, call our area salesman or write direct to:

The Torrington Company, Specialties Division, 777 Field Street, Torrington, Conn.

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Makers of Torrington Needle Bearings

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glass cloth laminates.

The tests showed that monofilament Dacron-reinforced polyester laminates had higher strength properties, with the exception of modulus of elasticity, than all other lami-

TABLE 2—PROPERTIES OF LAMINATES COMPARED

Type ➡	Glass	Orlon	Dacron[a]
Impact Str (Izod notched), ft-lb/in.			
Vacuum Bag	17.7	4.3	**24.6**
Contact Pressure	14.8	2.1	**21.5**
Ten Str, psi			
Vacuum Bag	14,000	3,350	**15,130**
Contact Pressure	—	3,540	15,160
Shear Str, psi			
Vacuum Bag	9,000	6,590	**12,250**
Contact Pressure	—	5,940	**12,020**
Flex Str, psi			
Vacuum Bag	22,000	9,140	**16,700**
Contact Pressure	—	7,870	**19,000**
Mod of Elast in Flexure, 1000 psi			
Vacuum Bag	1.00	0.45	**0.64**
Contact Pressure	—	0.50	**0.67**
Abrasion Res, sec/mil[b]	0.80	1.22	**1.17**
Adhesive Strength, psi[c]	34.0	Cloth failed	**100**

[a] Woven fabric of continuous-filament Dacron.
[b] Bureau of Standards abrasive jet method.
[c] Strength required to peel 2-in. strips from a 3-in. length of wood. Tests were performed on a Forest Products Laboratory toughness tester.

TABLE 3—DYNEL VS DACRON

Type ➡	Dynel	Dacron[a]
Impact Str (Izod notched), ft-lb/in.		
Vacuum Bag	—	16.8
Contact Pressure	—	9.0
Ten Str, psi		
Vacuum Bag	2,800	7,260
Contact Pressure	2,680	5,080
Shear Str, psi		
Vacuum Bag	5,310	7,390
Contact Pressure	5,120	7,070
Flex Str, psi		
Vacuum Bag	5,780	10,650
Contact Pressure	5,270	11,150
Mod of Elast in Flexure, 1000 psi		
Vacuum Bag	0.44	0.53
Contact Pressure	0.49	0.52
Abrasion Res, sec/mil[b]	1.28	—
Adhesive Strength, psi[c]	—	150

[a] Woven fabric of spun Dacron.
[b] Bureau of Standards abrasive jet method.
[c] Strength required to peel 2-in. strips from a 3-in. length of wood. Tests were performed on a Forest Products Laboratory toughness tester.

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nates tested. Laminates reinforced with spun Dacron, Dynel and Orlon fabrics were considerably inferior in strength properties to glass-reinforced laminates.

Table 2 shows the properties of glass, Orlon and continuous-filament Dacron-reinforced laminates. Table 3 shows the properties of Dynel and spun Dacron-reinforced laminates.

4. Reinforced plastics foams

New design information on a self-expanding, glass-reinforced plastics foam system was given by R. F. Newberg and D. L. Graham of Dow Chemical Co. The reinforced foam system is based on a self-expanding thermoplastic foam first reported in this magazine (see MATERIALS & METHODS, Apr '57, p 142).

The foam system, designated experimental plastic Q-4124.2, combines expandable polystyrene beads and an exothermic-type thermosetting resin (epoxy). When the two are mixed, and a curing agent and modifier added, the heat produced by the cure of the resin expands the beads to form the foam. As the beads expand they force most of the resin out to form a hard, chemical resistant surface on the part. The remainder of the resin acts as a binder and reinforcement between the individual expanded beads.

An outstanding feature of this system is its ability to incorporate reinforcing materials directly in the molding operation. A potential use for the self-expanding thermoplastic foam is in fiberglass-reinforced sandwich constructions. Because of the fluid nature of the system, these constructions can be fabricated without prior lay-up of a glass laminate shell. As the resin is forced throughout the sandwich construction by the pressure of the expanding beads, it is forced into and around the fibers of a reinforcing material that has been placed in the mold prior to charging the foam system. The pressure exerted against the mold sur-

PROPERTIES of most engineering materials can be found in the second edition of M/DE's *Materials Selector* reference issue, published last October. Names and addresses of suppliers are also listed.

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Toughness Ni-Resist ductile irons give elongations of 4 to 40%, together with good impact resistance. The photomicrograph below shows why – spheroidal graphite particles are dispersed in an austenitic matrix. This nickel alloy matrix develops full ductility and strength . . . keeps these properties at low temperatures.

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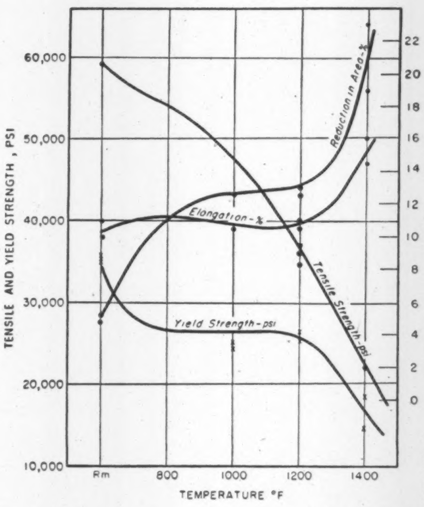
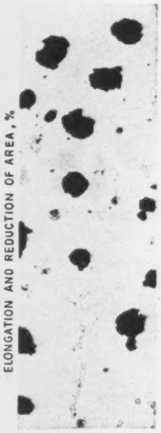


High temperature tensile properties of Type D-2 Ni-Resist ductile iron.



Ni-Resist ductile microstructure X 100. Spheroidal graphite particles allow the metal to develop the full strength and toughness of the high alloy austenitic matrix.

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Ni-Resist ductile irons form a tightly adhering scale at elevated temperatures, greatly reducing further oxidation. They resist heat effects up to 1400°F and higher, have excellent thermal shock resistance. From 1100° to 1300°F, Type D-2 has stress rupture properties equal to those of cast HF stainless steel.

Wear resistance Ni-Resist ductile irons have a work hardening austenitic matrix. Graphite particles provide dry lubrication. Both properties work together to resist wear and galling over a wide temperature range.

Erosion resistance Ni-Resist ductile irons work well in wet steam, brine or salt slurries, and high velocity liquids. Their high strength and resistance to cavitation-erosion mean long service life for pump parts.

Controlled expansion Ni-Resist ductile irons have thermal expansivities from about 2.5 up to 10.4 millionths per degree F. You can match them with steels, cast irons, Nickel, Monel* alloy...with aluminum, copper, bronze and stainless steel.

Non-Magnetic properties Ni-Resist ductile irons, Types D-2 and D-2C, are non-magnetic and therefore useful where excessive heat and power losses must be avoided.

Machinability Ni-Resist ductile irons machine as well as common pressure-type gray iron, thanks to the presence of graphite in their structure.

Fluidity in casting Ni-Resist ductile irons have good flowing qualities and permit the making of intricate designs.

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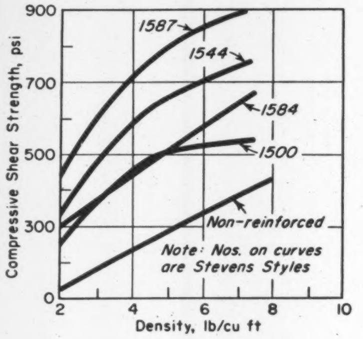

Fig 3—*Compressive shear strengths of thermoplastic foam sandwiches with various glass fabrics.*

face by the expansion of the polystyrene beads, and the resulting saturation of the glass reinforcement by the resin, produce a strong, uniform laminate as an integral part of the foam structure.

Another fabricating technique uses a gel coat backed up with a suitable glass reinforcement. The gel coat consists of a thin precoat of a catalyzed epoxy or polyester resin that is applied to the mold surface by spraying or brushing and allowed to cure before foaming the thermoplastic foam mixture. Before molding, dry reinforcing materials are pressed into the partially cured gel coat. The resin saturates the reinforcing material and bonds to the gel coat, producing a finished part that encloses a thermoplastic foam core.

Other techniques for producing reinforced plastics foams include pre-lay-up of laminated skins, sprayed laminates, and surfacing materials such as wood, metal and preformed plastics liners.

Compressive shear strength: The type of glass reinforcement used in thermoplastic foams has a significant effect on the compressive shear strength of molded sandwich structures. Fig 3 shows compressive shear strengths of thermoplastic foam sandwiches with various glass fabrics. Fig 4 shows compressive strengths of Q-4124.1 at various densities.

Flexural strength: Certain glass fabrics provide from 1½ to 3½ times greater flexural strength than non-reinforced moldings. Fig 5 shows

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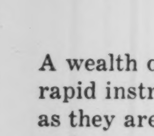

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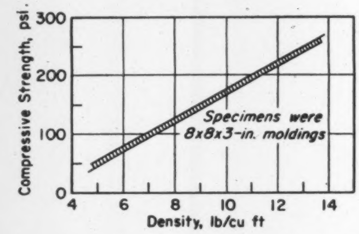


Fig 4—*Compressive strength of reinforced foam at various densities.*

flexural strengths of reinforced thermoplastic foam sandwiches with various glass fabrics.

Thermal conductivity: Reinforced thermoplastic foam structures have a thermal conductivity of 0.24 Btu/hr/sq ft/°F/ft at densities ranging from 5 to 8 lb per cu ft. This figure represents an equilibrium condition and is suitable for design purposes.

Water absorption: Fig 6 shows water absorption for two glass-reinforced thermoplastic foam sandwich structures after 30 days immersion.

Potential uses: Newberg and Graham say self-expanding, glass-reinforced thermoplastic foams have potential use in buoyancy, refrigeration and building applications. Specific applications in the refrigeration field include refrigerator doors and cabinets, cold storage tanks, structural insulation panels for trucks and freight cars, and air conditioning units. Holding devices for hinge and latch mechanisms may be encapsulated directly during the molding operation to produce a nearly finished part.

The light weight and low water absorption of glass reinforced thermoplastic foams (see Fig 6) make them useful for floats, buoys,

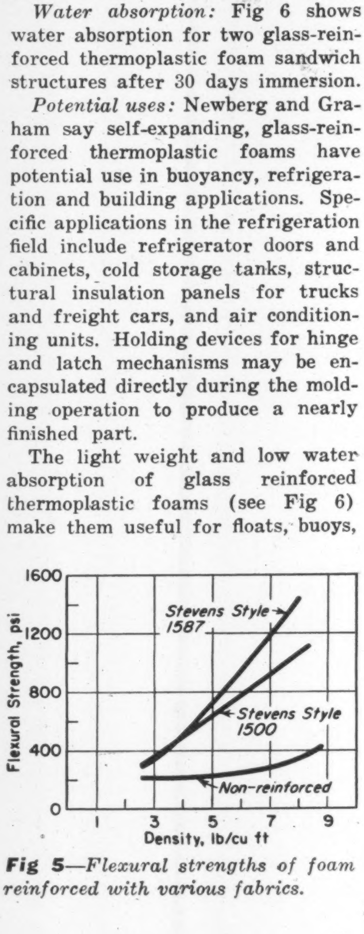
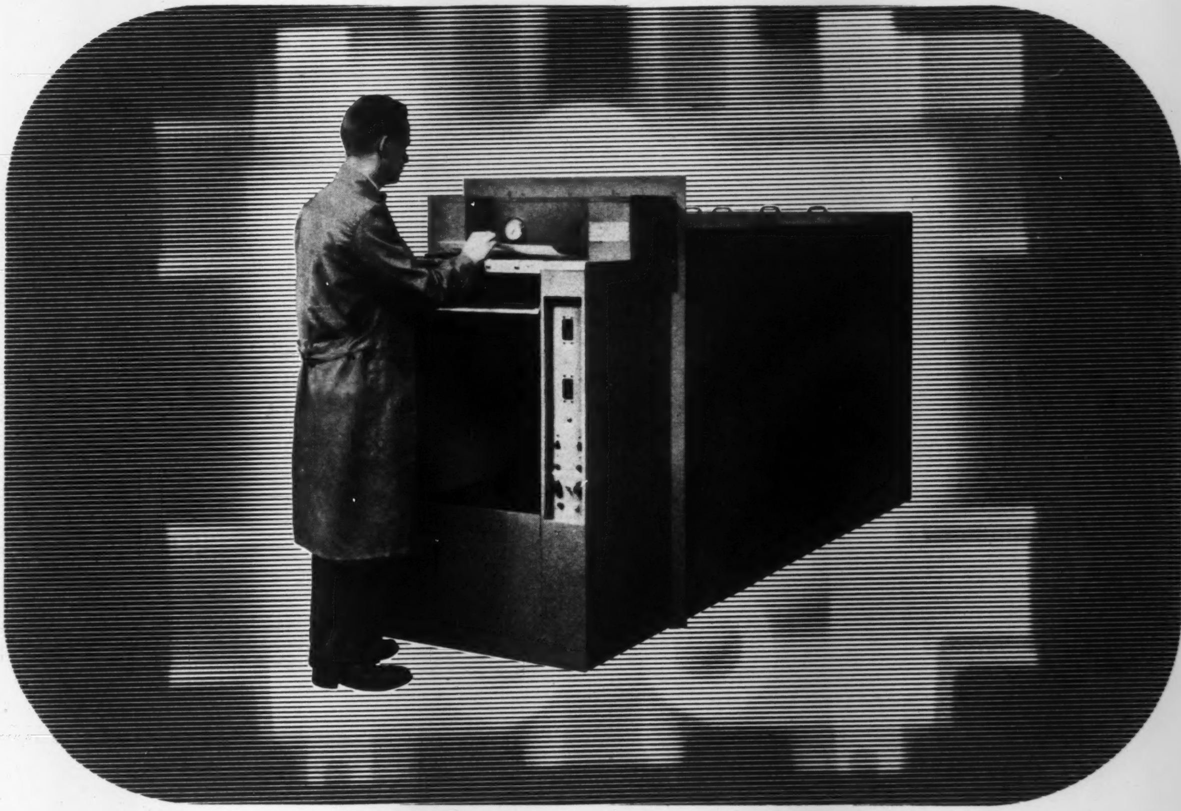


Fig 5—*Flexural strengths of foam reinforced with various fabrics.*



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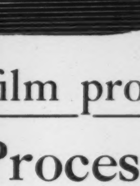

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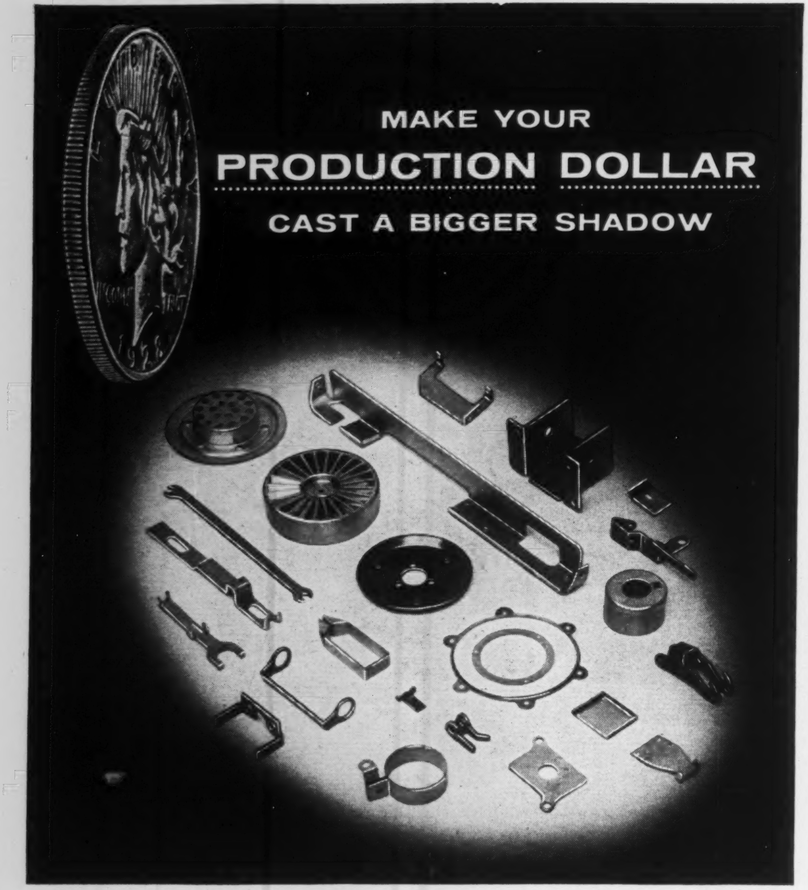

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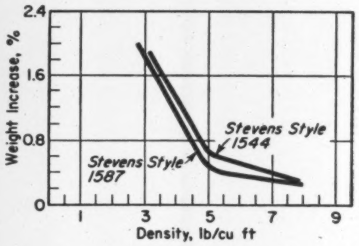

Fig 6—*Water absorption for two glass-reinforced foams after 30 days immersion.*

life preservers, decoys, pontoons and water sports equipment. Since the reinforced material is easy to fabricate, it has potential use in curtain walls, floor panels, doors, partitions and aircraft structures. Large floor panels have been molded which incorporate molded-in-place plastics pipe.

Other potential uses include encapsulation of electrical parts, decorative boat fins, women's shoe heels, tooling for vacuum forming molds, metal forming dies, cooling tower slats and anti-corrosive structures.

5. Shear effects in plastics laminates

Some important suggested changes in flexural test procedures resulted from a study of the effects of resin shear strength on fiberglass-reinforced polyester laminates. Results of the study were detailed by R. E. Chambers and F. J. McGarry of Massachusetts Institute of Technology. They found that:

1. When a resin with comparatively low shear modulus is used in a laminate, the apparent flexural modulus of the laminate is strongly affected. Thus, the interlaminar shear rigidity of a fiberglass-polyester laminate depends primarily on the shear modulus of the laminating resin.

2. The flexural modulus of a laminate, when the shear effect is eliminated, is merely the average of its tensile and compressive moduli determined from uniaxial tests, unless tensile and compressive moduli differ greatly in magnitude.

3. The ASTM recommendation for span-depth ratio in laminate flexural tests results in erroneous modulus values. The magnitude of the error

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Quality No. FABRIC BASE	22-005FO NYLON	21-009FO COTTON	22-006FO NYLON
Thickness	.013″	.013″	.050″
Tensile Strength—Lbs./Inch, Min.	75 x 75	80 x 80	300+ x 300+
Tear Strength—Lbs., Trap., Min.	2 x 2	2 x 2	25 x 25
Burst Strength—PSI, Mullens, Min.	125	125	500
Ozone Resistance at 60 Parts Per Million*	OK 208 Hr.	OK 208 Hr.	OK 208 Hr.
Fuel Resistance—Volume Change after 72 Hrs. at Room Temp. in ASTM High Aromatic Fuel**	+3.3%	+9.4%	+20.9%

*Ordinary diaphragm materials fail in 15 minutes under this test.
**Ordinary diaphragm materials swell about 20% under the same conditions.
††The above data are based upon tests on production experience and should not be used as specifications.

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seems to be dependent on the specific characteristics of a laminate.

4. Serious consideration should be given to using pure bending tests to measure the flexural properties of fiberglass-reinforced laminates.

Underplate of Iron Gives Pit-Free 'Chrome'

by Dr. Hyman Chessin and C. L. Alderuccio

A relatively new plating technique produces pit-free, heavy chromium electroplates on rolls and other parts used in the chemical and heavy equipment industries. Key to the method: parts are plated with iron to close up pits in the basis metal and to provide a smooth, homogeneous surface for chromium plating.

The iron electroplate, called Vanderloy, has physical properties comparable to those of low carbon steel. Fig 1 shows the very spongy surface of a cast iron part before iron plating. Fig 2 shows how the part looks after a single iron plating; all small pits are completely closed and the large ones nearly closed.

Rolls made of cast iron, plain carbon steels, and even high quality "clean" steels such as 4140 and 4340 develop numerous gas pits in the normal chromium plating process because they contain inclusions from casting, forging and rolling processes. Fig 3 shows a typical gas pit in a chromium-plated cast iron part.

Rolls and other parts used in the chemical industry must be free of these gas pits because: 1) the surface of rolls determines the surface configuration of materials being processed, such as photographic film; and 2) defects in the electroplate may contaminate the material being processed.

How parts are plated

Rolls and other parts are plated in the following sequence to obtain pit-free chromium electroplates:

1. A machined roll is first inspected for defects. Inspection is performed by marking the surface of the roll into 1 in. squares and

---

The authors are associated with Van Der Horst Corp. of America, Olean, N. Y.

problem:

A chemical company, using a cold water heat exchanger to cool caustic soda and sodium hypochlorite, was being plagued by breakage in the 2″ dia. glass tubing. Shutdowns occurred about three times monthly . . . each time consumed about 15 extra man-hours to change tubes . . . necessitated additional processing of contaminated hypochlorite.

solution:

A heat exchanger was fabricated from Carpenter Titanium Tubing. Ten-foot lengths of this tubing were vertically submerged directly in each caustic soda processing vat.

results:

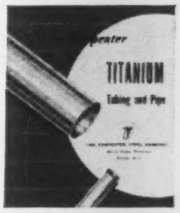
Maintenance costs reduced nearly $1500 annually! No tubing failure since Carpenter Titanium Tubing was installed two years ago! Increased production! Improved product quality! With a heat exchanger in each processing vat instead of separate unit, pumps and pump plumbing previously required to transfer highly corrosive fluid, and maintenance problems connected with them, have been eliminated!

Carpenter Titanium Tubing tames corrosion . . . reduces costs

Why not take advantage of the corrosion and cavitation resistance, light weight and high strength of Carpenter Titanium Tubing? It is the *least expensive* tubing you can use under many corrosion influences. It withstands conditions that reduce service life of ordinary metal . . . assures minimum downtime, fewer replacements.

Three commercial grades—C40, C55 and C70—in tubing sizes up to 4½″ O.D. are available.

In the food, chemical, pulp, paper and allied industries . . . the long, trouble-free service life of Carpenter Titanium Tubing provides countless opportunities to improve equipment performance and to reduce operating and maintenance costs. Contact your local Carpenter representative or distributor for the full story.



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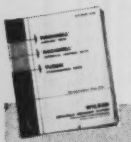

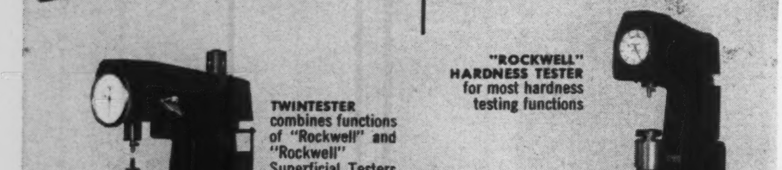
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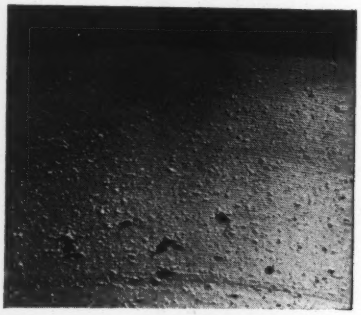


Fig 1—Cast iron has a spongy, pitted surface before iron plating.

examining each square under a microscope.

2. Any defects present in the basis metal are "dished out" with a grinding wheel to form a smooth surface. This grinding operation prevents many pits from developing in the chromium electroplate.

3. An iron plating covers the entire surface of the roll with an excess of iron. Inspection reveals whether or not more "dishing" and plating are necessary.

4. The roll is given a low temperature bake to relieve hydrogen embrittlement and to make the iron electroplate more machinable.

5. The iron electroplate is machined to a thickness of about 25 mils on each side of the roll, and superfinished to form a smooth surface for chromium plating. In general, the smoother the surface of the iron electroplate, the more homogeneous will be the structure of the chromium electroplate.

6. After machining, the iron-plated roll is given preplate treatments to insure good adhesion of the

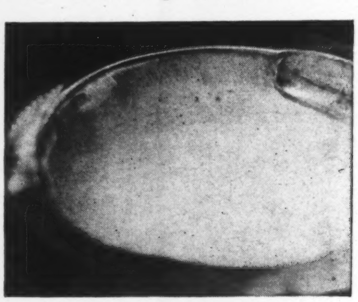
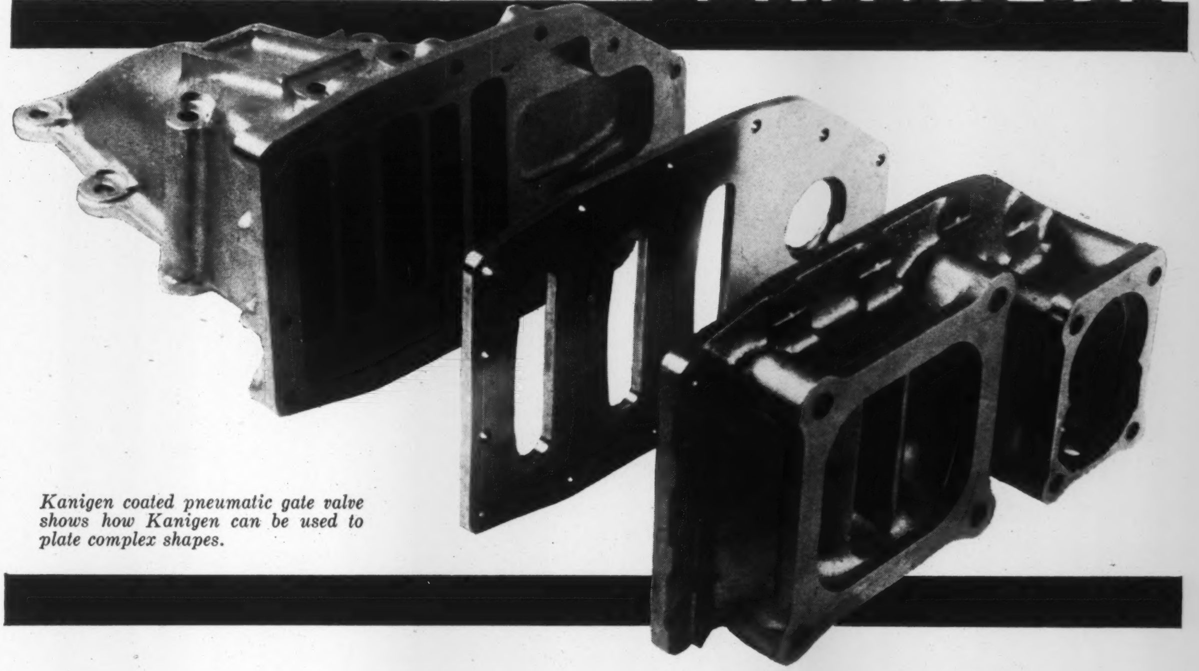


Fig 2—One coating of iron closes up most pits in cast iron part.

save on materials and labor with Kanigen®

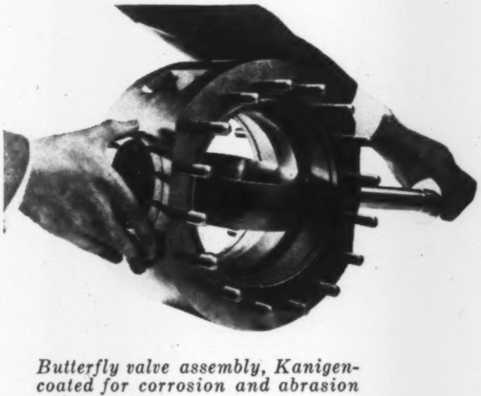


Kanigen coated pneumatic gate valve shows how Kanigen can be used to plate complex shapes.

KANIGEN is a chemically and metallurgically unique process that provides an extremely uniform, hard, corrosion and abrasion-resistant nickel alloy surface on most metals. You obtain practically the same end result with inexpensive, easily machined and fabricated materials that you do with expensive, difficult-to-work alloys. Where weight is a factor, **KANIGEN**-coated aluminum and aluminum alloys offer great advantages.

General American offers **KANIGEN** at Sharon, Pennsylvania; East Chicago, Indiana, and Compton, California and from licensees. Large production facilities for the plating of **KANIGEN** on iron, aluminum, copper, titanium and their alloys are available. Pilot-scale facilities for plating magnesium, beryllium, uranium, plastics and ceramics are maintained at our laboratory. For further information, call or write. You'll find *it pays to plan with General American.*

KANIGEN is a trademark which identifies chemical nickel coating by General American Transportation Corporation and its licensees, the product resulting therefrom and compositions produced by them for use in chemical nickel coating.



Butterfly valve assembly, Kanigen-coated for corrosion and abrasion resistance.

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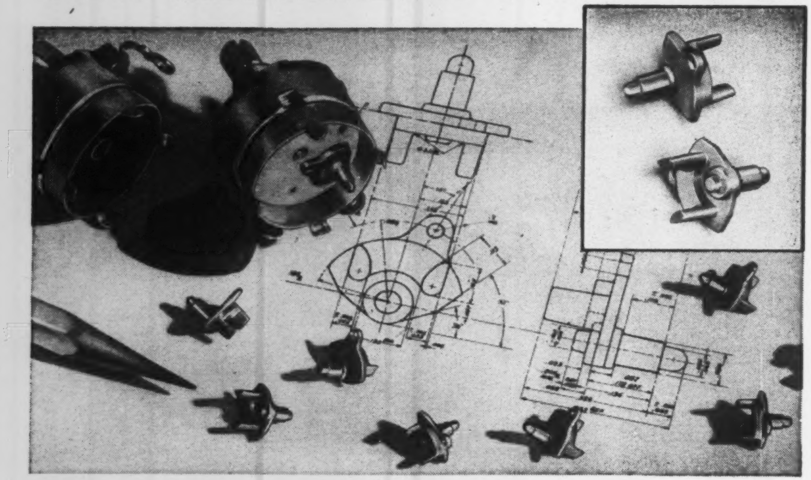

Washer base wing and cap nuts in die cast zinc alloy now cataloged by GRC

Save inventory, assembly time, and labor, with these wide-diameter washer base nuts. Eliminate separate washers. GRC offers prompt delivery from stock in a complete range of 14 thread sizes: #6 through 3/8". Specially suited for oversize bolt holes, adjusting slots, soft surfaces.

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Now available from stock: nylon hex nuts in ten sizes—#2 through 5/16". Nuts are single chamfered, washer-faced, double countersunk. Make the most of nylon's outstanding properties—high strength to weight ratio, excellent insulation, resiliency, resistance to abrasion, chemicals, corrosion, etc. See how these new nylon nuts complement GRC's extensive line of nylon screws. Samples sent immediately.

Uniformity and detail of actuator contours essential to proper functioning of special switch

A difficult parts design problem was solved with this tiny GRC die cast zinc alloy actuator which forms the basis of the Mallory OAC Line Switch for radios, television sets, record players and electronic equipment.
In a series of designs that started with a stamping and a screw machine piece involving multiple part assembly, Mallory engineers sought an actuating mechanism for a switch that would be capable of higher rating, longer life and greater dependability than switches using current-carrying springs. Such a control would require exceptional tolerances and critical dimensions to function properly. Uniformity would have to be assured as some of the contours couldn't be subjected to normal inspection procedures.
They found the answer in Gries' exclusive patented methods for the precise automatic production of tiny parts, and literally designed the switch around the GRC die casting.
Uniformly accurate, well within critical tolerances and solidly durable, this GRC actuator makes possible the simplest of switch construction.
This is just one of the many instances in which Gries' ingenious methods have opened the door for new products—at substantial savings. Parts are delivered ready for use . . . assembly and other secondary operations are eliminated.
For more information ask for the GRC bulletins on small zinc alloy die castings and molded plastic parts or send prints for immediate quotations. Maximum sizes 1¾" long, ½ oz. in zinc alloy; 1¼" long, .03 oz. in plastic. No size too small.

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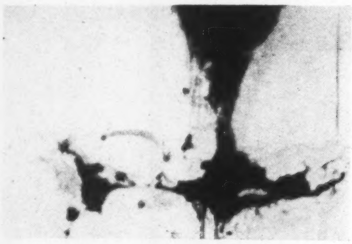

***Fig 3**—Pit in chromium electroplate is caused by gassing from defect in basis metal.*

chromium electroplate.

7. Chromium plate is applied. The bath is continuously filtered and maintained at close temperatures (± 1 °F).

Ceramic Coatings Withstand 3000 F

Aircraft and missile engine parts can be protected against oxidation and carbon pickup at temperatures of 2000 to 3000 F by coating them with metal-reinforced ceramics, recent research indicates. The coatings, still in the development stage, also withstand the severe mechanical vibrations encountered in aircraft and missile engines.

How coatings perform

Thermal insulating properties of the coatings were demonstrated by the following test:

An oxyacetylene torch was adjusted so that it would heat an uncoated, 0.050-in. thick panel of a nickel-chromium-molybdenum alloy (N-155) to 2100 F in 30 sec. The panel was then coated with an 0.136-in. thick reinforced ceramic coating and subjected to the torch. The coating provided a temperature lag of 1500 F for up to 40 sec and reduced the steady-state temperature of the metal by 500 F.

Using the same torch settings, panels coated with 0.030-in. thick coatings of unreinforced alumina and zirconia provided a temperature lag of 400 F for 30 sec and reduced

---

This article is based on a paper by Alan V. Levy, Marquardt Aircraft Co., and presented at the annual meeting of the Society of Automotive Engineers, Jan '59.

These are unretouched pictures of twice-folded **USS** Galvanized Steel Sheets. The sheet in the smaller picture is magnified three times actual size.

Handkerchief fold
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proves the zinc stays on

We cut a piece from a sheet of USS Galvanized Steel—bent it double—
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But look at the zinc coating along the outside of the bend. Not one bit of the coating flaked off! What's more, we restraightened the sheet and still not one speck of zinc came loose!

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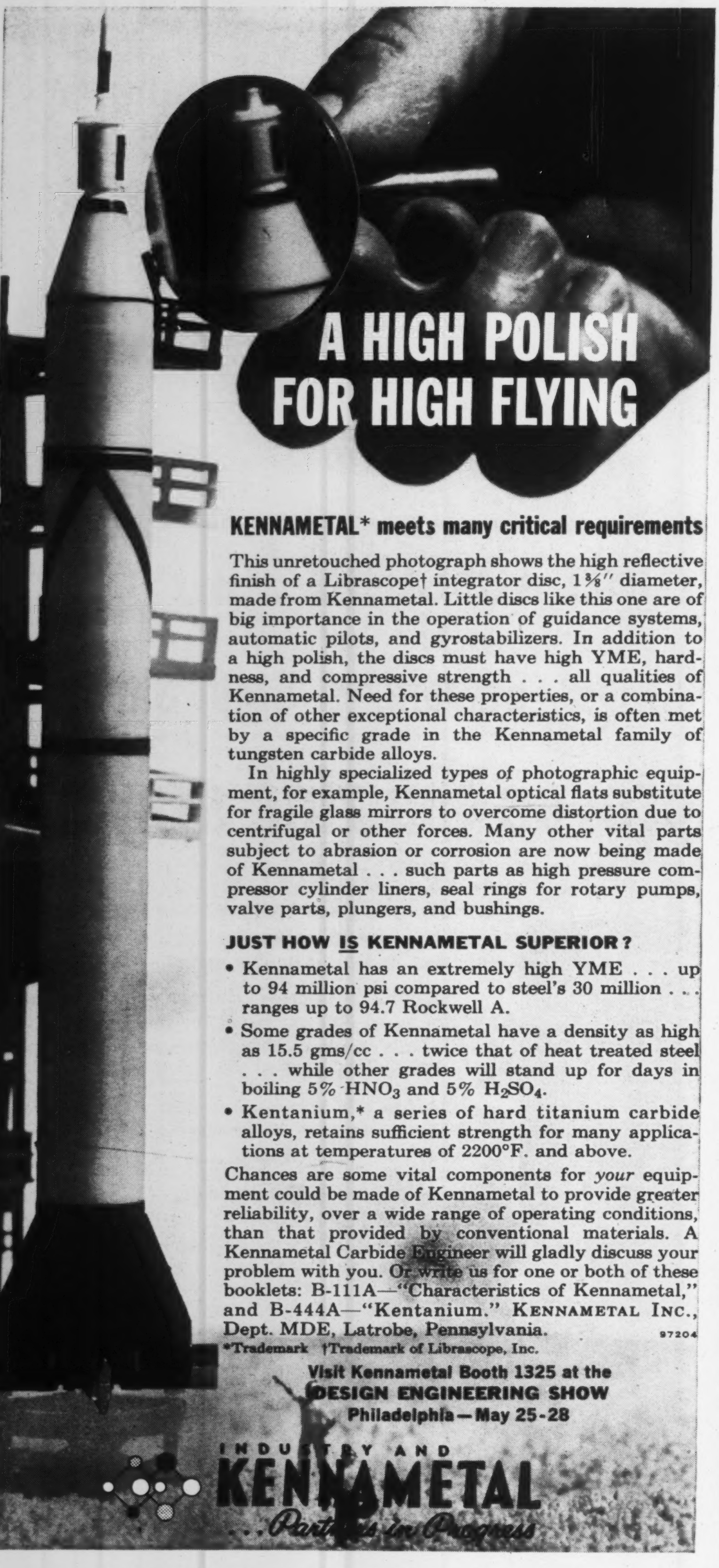
A HIGH POLISH FOR HIGH FLYING

KENNAMETAL* meets many critical requirements

This unretouched photograph shows the high reflective finish of a Librascope† integrator disc, 1⅜″ diameter, made from Kennametal. Little discs like this one are of big importance in the operation of guidance systems, automatic pilots, and gyrostabilizers. In addition to a high polish, the discs must have high YME, hardness, and compressive strength . . . all qualities of Kennametal. Need for these properties, or a combination of other exceptional characteristics, is often met by a specific grade in the Kennametal family of tungsten carbide alloys.

In highly specialized types of photographic equipment, for example, Kennametal optical flats substitute for fragile glass mirrors to overcome distortion due to centrifugal or other forces. Many other vital parts subject to abrasion or corrosion are now being made of Kennametal . . . such parts as high pressure compressor cylinder liners, seal rings for rotary pumps, valve parts, plungers, and bushings.

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Chances are some vital components for *your* equipment could be made of Kennametal to provide greater reliability, over a wide range of operating conditions, than that provided by conventional materials. A Kennametal Carbide Engineer will gladly discuss your problem with you. Or write us for one or both of these booklets: B-111A—"Characteristics of Kennametal," and B-444A—"Kentanium." KENNAMETAL INC., Dept. MDE, Latrobe, Pennsylvania. 97204

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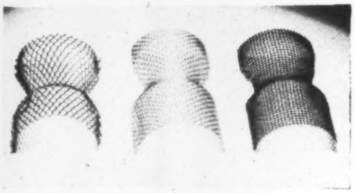


Metal reinforcements *for ceramic coatings include expanded steel (left), stainless steel mesh (center) and carbon steel mesh (right).*

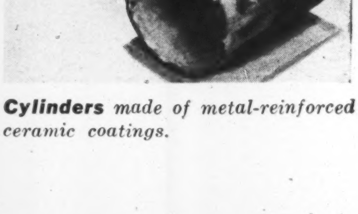
the steady state temperature of the panel by 100 °F.

Mechanical property tests on the coatings are not yet complete. Tests to date show that metal-reinforced phosphate-bonded coatings — both alumina and zirconia—have good resistance to thermal shock, vibration and flexing.

Room temperature tests on an unreinforced phosphate-bonded alumina composition show the material has a modulus of rupture in excess of 4000 psi. This value compares favorably with that for other ceramic bodies.

Types of coatings

Several types of ceramic coatings have been developed. They include sodium silicate-base compositions containing such refractories as alumina, silica and mullite; phosphate-bonded alumina and zirconia; and pure alumina and zirconia. These ceramic compositions have been reinforced with the following: 1) wire mesh made from mild and stainless steel, or molybdenum; 2) expanded metal made from mild and stainless steel, or molybdenum; 3) corrugated metal strips made from mild and



Cylinders *made of metal-reinforced ceramic coatings.*

THE DODGE STEEL
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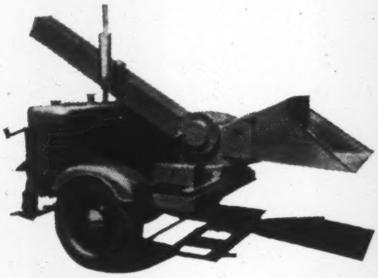
PUBLISHED BY **DODGE STEEL COMPANY**
6501 Tacony Street, Philadelphia 35, Pa.

Notes on Dodge foundry engineered product improvements

More and more designers and purchasers of steel castings are taking advantage of Dodge's unique 3-way engineering service to obtain better, more efficient parts. Complete facilities are available at Dodge to assist in the proper design and specification of a proposed new casting . . . to review present castings in order to determine how they may be redesigned to save metal and increase strength . . . and to help in converting other metals and forms to steel castings. Here are typical examples of the effectiveness of this service:

INGENIOUS TREE CHIPPER

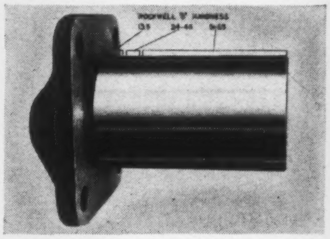
Helping to solve the brush disposal problem is this ingenious, portable Tree Chipper, that can be taken directly to the operation to "make little ones out of big ones".



A major part of the Chipper is a Dodge cast and machined steel roller, 9 inches long, 11½ inches in diameter and weighing 275 pounds. The cast steel roller, featuring three horizontal cutting blades, is so geared that it travels at a speed of 2,200 rpm. Brush and limbs up to 6″ diameter are fed into the machine and cut up into small chips. The use of a quality steel casting in this application assures uniform, predictable results, as well as long service life.

FAREWELL TO BREAKAGE

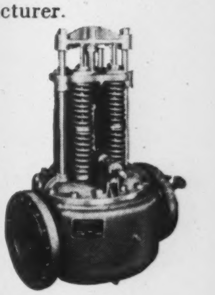
A well-known truck trailer manufacturer experienced extensive breakage of a trunnion pin in its trailer rear wheel tandem assemblies. The pin, used to support an equalizing beam, was not strong enough to take the punishing movement of heavy loads. New specifications called for a pin with a bearing surface ductile enough, yet with sufficient strength to do the job. Cost was to be kept low. Dodge designed, built, and machined the casting shown here.



The pin uses a special grade of Dodge steel which responds to differential grades of hardness along its surface, depending on the required stress demand. Result? Breakage problem eliminated with a steel casting produced at low cost.

STEAM LINE INSURANCE

In power plants and other systems utilizing high-pressure, high-temperature steam, the safety of workers as well as equipment is important. One safe and efficient pressure device—used in thousands of installations—is this relief valve made by a leading manufacturer.



Proper design coupled with the use of quality steel castings are good reasons why these valves have provided safe, efficient operation for so many years.

The best proof of the savings available to *your* company through the use of Dodge 3-way engineering service is the experiences of these manufacturers and others who have had problems similar to yours. This timely and valuable service is ready to go to work for you. May we study and solve your problem?

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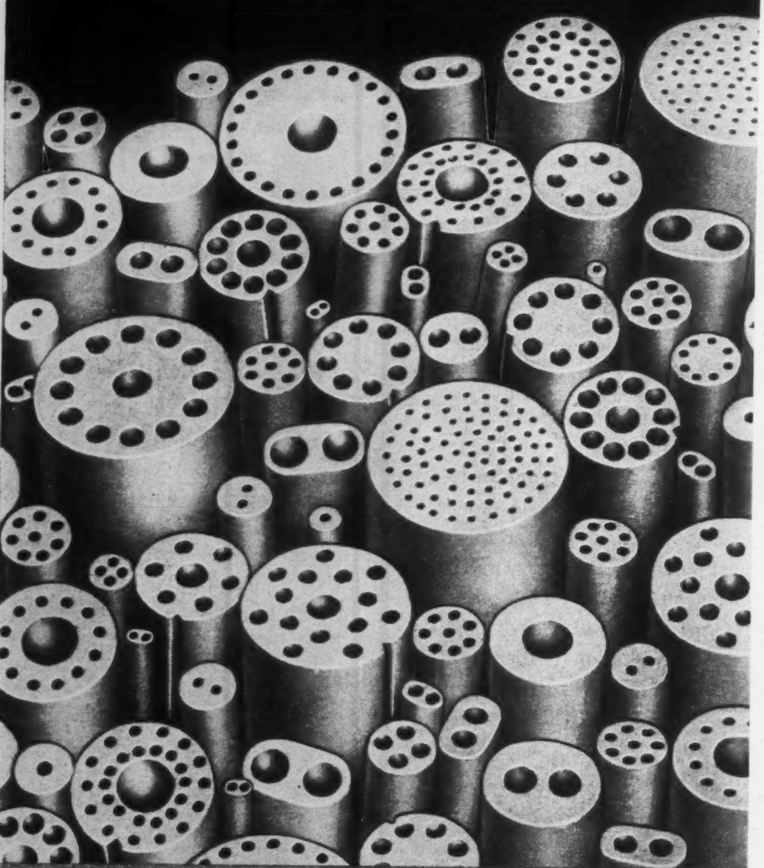
HIGH TEMPERATURE!
ALUMINA OR MULLITE



THERMOCOUPLE INSULATORS
FOR TEMPERATURES TO 3600° F!

High-temperature ceramic insulators! Sizes .020 and larger! 1-inch, 2-inch and 3-inch lengths! Special sizes, shapes and lengths and multiple bore quickly available.

Write for information.

McDANEL Industrial CERAMICS
1959-OUR 40th ANNIVERSARY

McDANEL
REFRACTORY PORCELAIN COMPANY
BEAVER FALLS . PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 430

PROPERTIES OF REINFORCED CERAMIC COATINGS

Type ➡	Phosphate-Bonded Alumina[a]	Phosphate-Bonded Zirconia[b]
Density, lb/cu in.	0.11	0.14
Max Service Temp, F	3500	4000
Ther Drop, °F/0.001 in.	8	10
Ther Cond (2400 F), Btu/hr/sq ft/°F/in.[c]	7.2	6.0
Emissivity (3000 F)	0.2	0.4

[a] Reinforced with steel or molybdenum and baked at 800 F.
[b] Reinforced with molybdenum and baked at 800 F.
[c] Calculated from thermal drop data.

stainless steel, or tantalum; and 4) ceramic fibers made of aluminum silicate or quartz.

Wire mesh and expanded metal reinforce the coating and provide a means of firmly anchoring it to the base metal. Metal reinforcements are brazed or resistance welded to the base metal before the coating is applied. Reinforcements made of molybdenum metal can be protected with an oxidation resistant coating. Nonmetallic reinforcements such as ceramic fibers are mixed directly into the ceramic insulation.

How coatings are applied

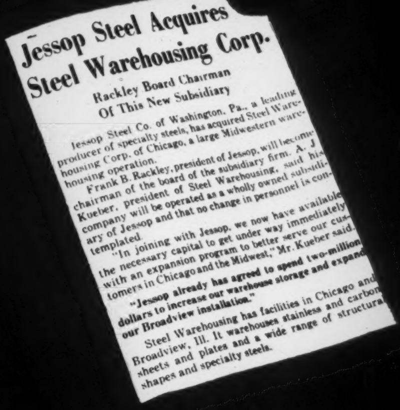
The ceramic compositions are applied by two methods: 1) flame spraying, as in the case of pure alumina and zirconia, and 2) troweling, as in the case of phosphate-bonded and silicate compositions. Flame sprayed coatings can be used in the as-applied condition, whereas troweled coatings usually require baking at 800 F or lower.

Other News . . .

Metals

▶ Pure beryllium has been successfully hot rolled into sheets by Beryllium Corp., P. O. Box 1462, Reading, Pa. The sheets are expected to find use in aircraft, nuclear and electronic applications.

▶ A bright-tinned steel wire has been introduced by Continental Steel Corp., 1109 S. Main St., Kokomo, Ind. The wire can be used in place of tin-plated wire in many applications. The wire is said to retain its brightness for long periods of time in



Jessop Steel Acquires Steel Warehousing Corp.

Rackley Board Chairman Of This New Subsidiary

Jessop Steel Co. of Washington, Pa., a leading producer of specialty steels, has acquired Steel Warehousing Corp. of Chicago, a large Midwestern warehousing operation.

Frank B. Rackley, president of Jessop, will become chairman of the board of the subsidiary firm. A. J Kueber, president of Steel Warehousing, said his company will be operated as a wholly owned subsidiary of Jessop and that no change in personnel is contemplated.

"In joining with Jessop, we now have available the necessary capital to get under way immediately with an expansion program to better serve our customers in Chicago and the Midwest," Mr. Kueber said.

"Jessop already has agreed to spend two-million dollars to increase our warehouse storage and expand our Broadview installation."

Steel Warehousing has facilities in Chicago and Broadview, Ill. It warehouses stainless and carbon sheets and plates and a wide range of structura shapes and specialty steels.

Jessop buys Steel Warehousing Corporation ... another reason for your confidence!

When you specify Jessop specialty steels, you've got good reasons for that decision. For example . . .

With Jessop, you're dealing with success. Although it's only two years since the acquisition of Green River Steel, Jessop now adds Steel Warehousing of Chicago. Already a two million dollar expansion of warehousing facilities is underway.

This fast growth didn't just happen. It results from the Jessop policy of producing the highest quality specialty steels *and keeping delivery promises!*

Yes, you have good reasons to be confident when you specify Jessop.

VMA 6721

JESSOP
STEEL COMPANY
Washington, Pennsylvania

Subsidiary Companies:

Green River Steel Corporation, Owensboro, Kentucky
Jessop Steel International Corporation, New York City
Jessop Steel of Canada, Ltd., Wallaceburg, Ontario
Steel Warehousing Corporation, Chicago and Broadview, Ill.

Stainless, alloy, tool, cast-to-shape, and forging steels, precision ground flat stock, and other specialty steels.

For more information, turn to Reader Service card, circle No. 536

for custom rubber parts
to your exact requirements
8423-SR

. . . *specify* STALWART!

MOLDED
EXTRUDED
SPLICED
DIE CUT
MACHINE CUT
HAND CUT
PRECISION GROUND

Channels or chicken pluckers . . . washers or weatherstrips . . . you name it and we'll make it! And we'll produce it to meet your most precise design specifications! Stalwart offers you a complete rubber parts *service* . . . Rubber Engineers develop your special compound from natural, synthetic or silicone rubbers . . . Laboratory Technicians pre-test actual performance . . . our own completely equipped Tooling Department produces the necessary extrusion dies . . . skilled Production Personnel operate the latest rubber machinery for maximum economy, dependable delivery . . . and *our* Quality Control Department protects *your* interests! This means you get higher quality at a lower cost . . . the result of nearly 40 years of fabricating experience! To solve tough rubber parts problems . . . cut assembly costs, *specify Stalwart.*

Write today for complete information.
Ask for your copy of Stalwart Catalog SR-59.

STALWART
RUBBER COMPANY

165 Northfield Road • Bedford, Ohio
Manufacturing facilities in
Jasper, Georgia and Bedford, Ohio

For more information, turn to Reader Service Card, circle No. 400

normal use, and is said to have excellent workability.

▶ Johnston & Funk Metallurgical Corp., W. Kemrow Ave., Wooster, Ohio is using a new vacuum melting technique to remove the major contaminants, oxygen and nitrogen, from titanium ingots.

▶ Uniform Tubes, Inc., Level & School Rds., Collegeville, Pa. is now producing a complete line of seamless tubing from beryllium copper in diameters ranging from 0.010 to 0.625 in., and in wall thicknesses from 0.001 to 0.042 in.

Nonmetallics

▶ Foster Grant Co., Inc., 289 N. Main St., Leominster, Mass. has begun production of a styrene-acrylonitrile copolymer called Fostacryl. The company says the material is almost crystal clear. Potential uses: tumblers, dinnerware, pen barrels, food containers and fan blades.

▶ A polyethylene custom blending and compounding service called Poly-Blends has been announced by Plastic Materials, Inc., New South Rd., Hicksville, N. Y. and Thermo Plastic Materials, Inc., 2929 N. Campbell Ave., Chicago 18. The custom blended compounds, composed of linear and regular polyethylene resins, are of special use for blow molding.

▶ An improved polyethylene pipe compound is said to have greater initial burst strength and better resistance to stress cracking than conventional polyethylene pipe compounds. The compound, designated DHD-4022, is marketed by Union Carbide Plastics Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17.

▶ An improved electrical insulation made of irradiated polyolefin has been introduced by Enflo Corp., Fellowship Rd. & Rte. 73, Maple Shade, N. J. The material, called Enrad II, has a dielectric strength of 1000 v per mil and a dissipation factor of 0.0005.

▶ A linear polyolefin resin has been developed specifically for blending with regular polyethylene. The material, called Fortiflex A-800, is available from Celanese Corp. of America, Plastics Div., 744 Broad St., Newark 2, N. J.

▶ Fome-Cor is the name given to a new foamed plastics-paper sandwich material. The product is said to have high compression strength under severe moisture conditions, and good

For more information, circle No. 488 ➤

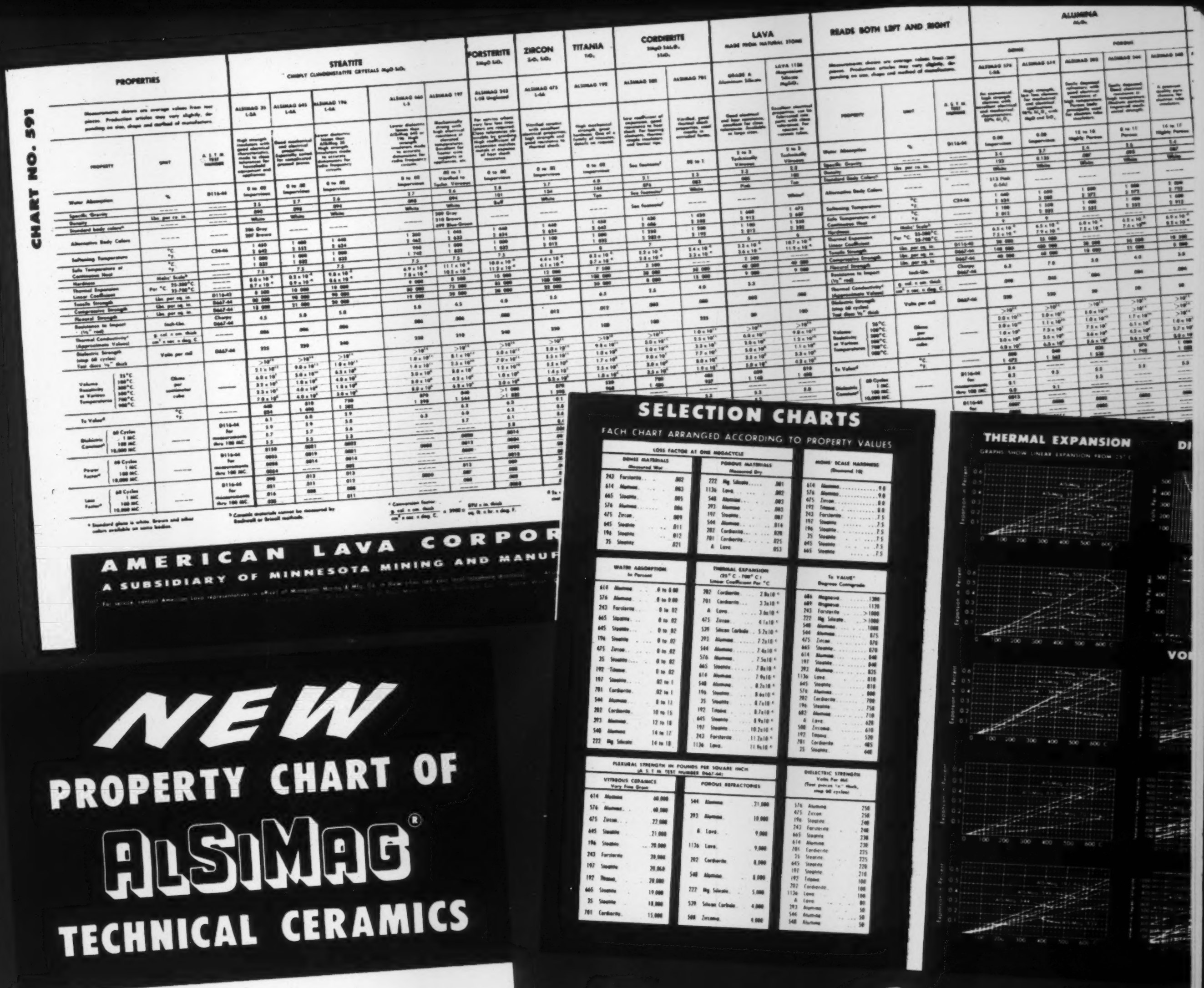


CHART NO. 591
AMERICAN LAVA CORPOR
A SUBSIDIARY OF MINNESOTA MINING AND MANUF
SELECTION CHARTS
EACH CHART ARRANGED ACCORDING TO PROPERTY VALUES
THERMAL EXPANSION

NEW PROPERTY CHART OF ALSIMAG® TECHNICAL CERAMICS

Yours on Request!

WHAT ALSIMAG IS

The AlSiMag trade mark includes the widest variety of technical ceramics available from any single source . . . backed by the most inclusive custom manufacturing facilities in the industry. Now well into its second half century of leadership in technical ceramics, this is the place you are most apt to get what you want, when you want it.

WHAT THE CHART TELLS

The chart gives principal physical and electrical characteristics of the most frequently used AlSiMag compositions. If your work includes design, production or purchasing you will find this chart valuable. It is completely factual and is of convenient file size.

WHERE ALSIMAG IS USED

AlSiMag ceramics are unexcelled in electronic and electrical applications because of their superior dielectric properties, especially at elevated temperatures. They have many mechanical and chemical applications.

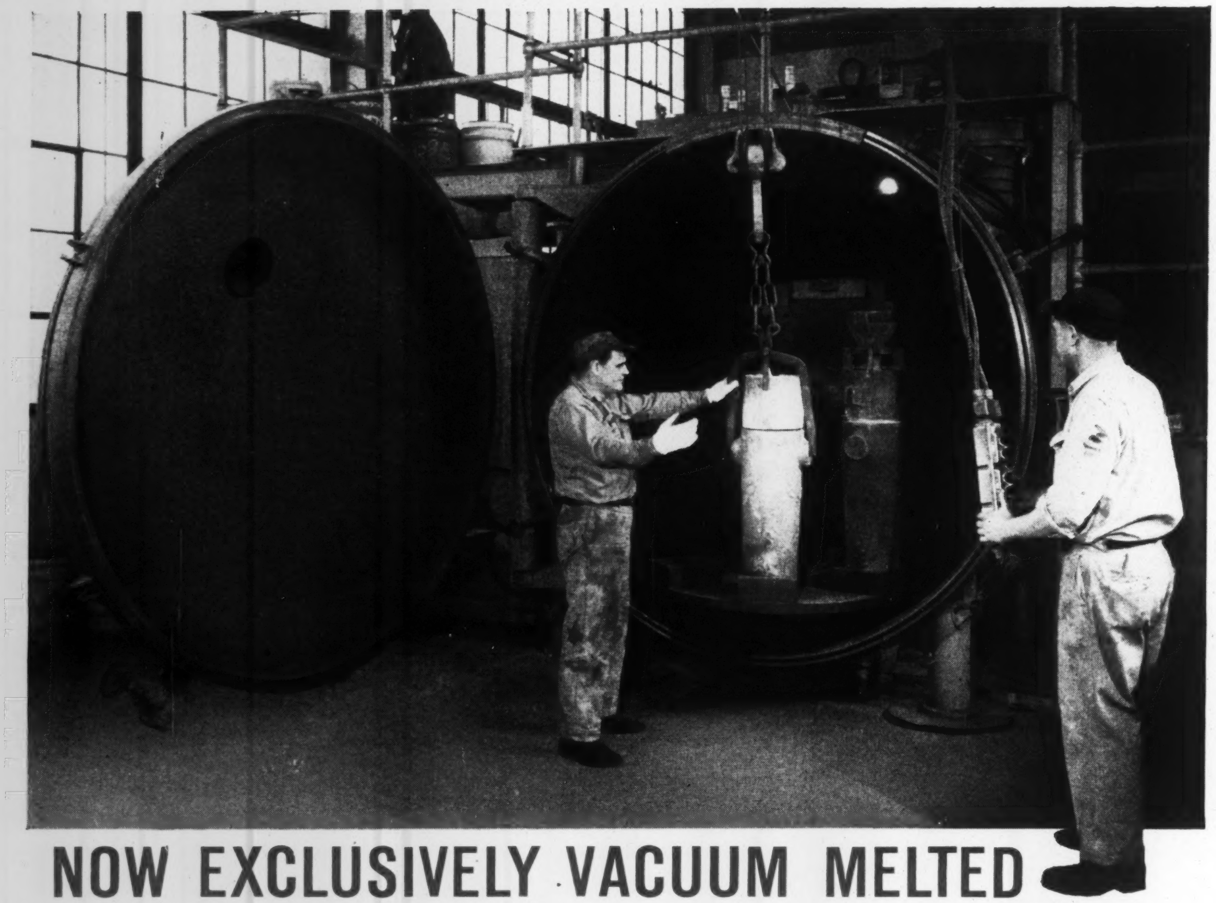
You may choose compositions from this chart which have various combinations of these characteristics. Permanently rigid. Chemically inert. Withstand high temperatures. Hard (up to 9 on Mohs' scale) and abrasion resistant. Non-magnetic. Will not rust, oxidize or corrode. Do not deteriorate with time. Metal-ceramic combinations can be accomplished. Materials are available with expansion coefficients varying over a wide range. Precision tolerances can be maintained. The chart, sent on request, gives details, saves you valuable time.

A Subsidiary of
Minnesota Mining and
Manufacturing Company

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENN.
58TH YEAR OF CERAMIC LEADERSHIP

For service, contact American Lava representatives in Offices of Minnesota Mining & Manufacturing Co. in these cities (see your local telephone directory): Boston: Newton Center, Mass. • Chicago: Bedford Park, Ill. • Cleveland, O. • Dallas, Texas • Los Angeles, Cal. New York: Ridgefield, N. J. • Philadelphia, Pa. • St. Louis, Mo. • St. Paul, Minn. • So. San Francisco, Cal. • Seattle, Wash.
All other export: Minnesota Mining & Manufacturing Co., International Division, 99 Park Ave., New York, N. Y.



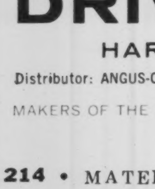
NOW EXCLUSIVELY VACUUM MELTED
KARMA High Resistance Alloy
THERLO Glass Sealing Alloy

This dramatic "first" in the manufacture of nickel alloys by Driver-Harris has been achieved by expanded vacuum melting capacity. It is still another example of our continued leadership in producing electrical and electronic nickel alloys of the highest purity.

D-H vacuum melting produces alloys of higher ductility and tensile properties. These are achieved by greatly reducing inclusions, especially oxides and nitrides. Other direct benefits are elimination of gas, not only from the surface but from the entire mass, and general improvement in the electrical, electronic and mechanical properties to meet critical specifications.

For additional information about Karma, Therlo and the other 130 high-nickel alloys manufactured by Driver-Harris, write for a copy of the D-H Alloy Manual.

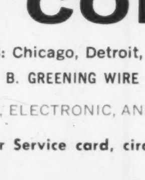
*T.M. Reg. U.S. Pat. Off.



VACUUM MELTED KARMA* *High Resistance Wire*

The temperature coefficient of superior KARMA resistance wire has been improved to less than ±10 parts per million from —60°C. to +125°C. Higher stability and linearity are added to these important properties.

- **Low thermal EMF against copper (equaled only by Manganin)**
- **Improved ductility**
- **High resistance to oxidation**
- **Wire sizes down to .0005″**
- **800 ohms per circular mil foot**



VACUUM MELTED THERLO* *Glass Sealing Alloy*

Improved workability is the major result of vacuum melting THERLO . . . the long established cobalt, nickel, iron alloy for sealing to hard or thermal shock resistant glass. THERLO also:

- **Produces a permanent vacuum-tight seal with simple oxidation procedure**
- **Resists mercury**
- **Is readily machined and formed—deep drawn or spun**
- **Can be welded, soldered, brazed**
- **Is available as rod, wire, strip, sheet foil—and in special shapes**

DRIVER-HARRIS* COMPANY

HARRISON, NEW JERSEY • BRANCHES: Chicago, Detroit, Cleveland, Louisville

Distributor: ANGUS-CAMPBELL, INC., Los Angeles, San Francisco • In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario

MAKERS OF THE MOST COMPLETE LINE OF ALLOYS FOR THE ELECTRICAL, ELECTRONIC, AND HEAT-TREATING INDUSTRIES

SPECIAL PURPOSE ALLOYS SINCE 1899
TRADE MARK REG. U.S. PAT. OFF.

For more information, turn to Reader Service card, circle No. 541

insulating and cushioning properties. It was developed by Fome-Core Corp., Springfield, Mass.

Finishes

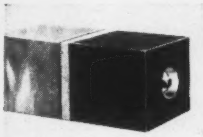
- An etchant, called Alsite, has been introduced by Kelite Corp., 81 Industrial Rd., Berkeley Heights, N. J. for use on aluminum and aluminum alloys. The etchant is said to produce a finish on aluminum that hides die marks and some structural imperfections.
- Two new iron phosphate coating materials have been developed by Klem Chemicals, Inc., 14401 Lanson Ave., Dearborn, Mich. for coating ferrous and nonferrous metals at room temperature. Klem Kote No. 323 is recommended for 5-stage systems, Klem Kote No. 905 for 2 or 3-stage systems.
- An improved etching and cleaning compound for aluminum produces a fine, uniform etch and leaves the surface of aluminum free from aluminum hydroxide films. The product, called Etchalume 14, is available from Enthone, Inc., 442 Elm St., New Haven 8, Conn.
- A bright gold plating solution called Bartalloy-P has been introduced by Bart Mfg. Corp., 227 Main St., Belleville, N. J. for use on electronic parts and decorative items. The plating solution is said to produce a deposit equivalent to 18 carat gold.

Joining materials

- Addition of a new heat reactive phenolic resin to neoprene cements is said to improve their adhesion to Dacron, nylon, rayon, glass, metals and unplasticized plastics films. The phenolic resin, called Durez 19428, is made by Durez Plastics Div., Hooker Chemical Corp., North Tonawanda, N. Y.
- A line of ferrous and nonferrous retaining rings, called Rotor Clips, are available for use as fasteners in appliances, automobiles, aircraft and electronic and electrical equipment. Ring size is engraved on each piece. The retaining rings are products of Rotor Clip Co., 114 Allen Blvd., Farmingdale, N. Y.
- A water-base latex cement is said to combine the strength and durability of solvent-type adhesives with the economy of latex cements. The cement, called Kwik, is suitable for cementing plastics, leather, rubber, aluminum and fabrics. It is available from Adhesive Products Corp., 1660 Boone Ave., New York 60.

ONLY ACOUSTICA ULTRASONIC CLEANERS HAVE MULTIPOWER!

MAJOR BREAKTHROUGH IN ULTRASONIC TECHNOLOGY!



In determining which ultrasonic cleaner to buy, remember that all ultrasonic cleaners are not alike. There is variation in uniformity of cavitation. There is variation in the transducer — and the transducer is the heart of an ultrasonic cleaner. The Multipower transducer developed by Acoustica research, multiplies the power and efficiency of ultrasonic action. Cleaning is faster, labor costs are lower.

Acoustica ultrasonic cleaners are engineered and produced to the finest standards, unequaled in quality and value. Off-the-shelf in capacities from 1 to 75 gal. or custom built to 5000 gal. Expert Acoustica engineers can help you with your cleaning problems.
Send for further information.

acoustica
Leader in research and development of ultrasonic systems
Los Angeles and New York

Acoustica Associates, Inc.
Dept. MDE, 25 Windsor Ave., Mineola, N. Y.
Send information describing advantages of Acoustica ultrasonic cleaners.

Name__________
Company__________
Address__________
City__________ Zone_____ State_____

For more information, turn to Reader Service Card, circle No. 456

THE NATIONAL SCENE
DANGER
HIGH VOLTAGE

"YOUR NEXT POLYESTER COMPONENT: mold it or machine it?"

Get an unbiased answer from National because we work either way

Giving the designer facts to help make the *right* design decision faster is perhaps our best "product." Offering the broadest line of plastic materials and services permits us to give impartial help. Take polyester glass mat.

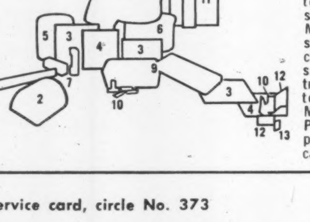
If the facts about configuration, volume, performance, operating conditions and cost point to a *molded* polyester shape, we'll work from scratch—or from your drawings—and deliver 100% usable parts.

If the same facts point to a *machined* part, we'll work the same way . . . and with the same results. In this case National can furnish four standard grades from which to select the one best material. GP-9100-A is our general purpose, medium cost sheet with good electrical and mechanical properties. GP-9104 is also general purpose, but lower cost. GP-9202 is our flame resistant grade and best electrical grade except for arc resistance. GP-9204 is both flame *and* arc resistant, UL-approved for sole support of current carrying parts at temperatures up to 150°C.

One more point. The problems inherent in machining polyester glass laminates have had a tendency to discourage some designers from considering it. We suggest that you bounce this headache out of your production facilities and into ours.

You see, we are interested in *both* your design and machining problems. Your component will be skillfully machined at one of our four complete, "service-located" fabricating facilities.

Send for our Polyester Technical Bulletin 1164. We'll be happy to include, also, data on the full line of National materials—over 100 grades. Write to National Vulcanized Fibre Co., Dept. KK-5, Wilmington 99, Delaware.



1. Silk screened sign, polyester sheet. **2.** Molded weldor's helmets. **3.** Polyester sheet, natural. **4.** Polyester sheet, black. **5.** Molded radome cover for traffic radar detector. **6.** Molded explosive powder bucket. **7.** Molded photographic film splicer housing. **8.** Machined circuit breaker support bar. **9** Molded tray & lid. **10.** Punched terminal boards. **11.** Molded bread tray. **12.** Punched electric arc suppressor. **13.** Machined cam block.

For more information, turn to Reader Service card, circle No. 373

DANGER
HIGH VOLTAGE

CHOOSE FROM THESE MATERIALS...

Vulcanized Fibre: 10 standard grades; many special grades.

PHENOLITE® Laminated Plastic: over 80 standard and modified grades; paper, cotton fabric, nylon, asbestos, glass fabric, cotton and glass mat bases; phenolic, melamine, polyester, epoxy Teflon or silicone resins.

PEERLESS Electrical Insulation: coil, strip, corrugated.

Extruded Nylon: 2 grades; rod, strip, pressure tubing, special shapes.

Polyester Glass Mat: 4 standard sheet grades; custom molded shapes.

PHENOLITE Copper-Clad Laminates: 10 standard grades.

Combination Materials: Rubber-PHENOLITE; Rubber-Fibre; Wood-Fibre; Metal-Fibre; Asbestos-Fibre; PEERLESS-PHENOLITE.

BACKED BY THESE SERVICES...

Field Application Assistance
Complete Fabricated Parts Service
Stock Program for Immediate Shipment

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WILMINGTON 99, DELAWARE
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NATIONAL FIBRE COMPANY OF CANADA, LTD., Toronto 3, Ontario

MATERIALS AT WORK

cont'd from p 12

Specially treated faring kit is used for . . .

. . . in-flight refueling.

Refueling Kit Gets Special Pretreatment

The use of a special pretreatment has eliminated several problems in the design of an in-flight refueling faring kit.

The faring kit, used on the Douglas A3D-2 Skywarrior, is subjected to considerable stress by the heavy probes and fuel transfer unit used in the refueling operation. Allegheny Ludlum Steel Corp.'s AM-350 precipitation hardening stainless steel was selected for the part because it is strong and easily formed.

The problem

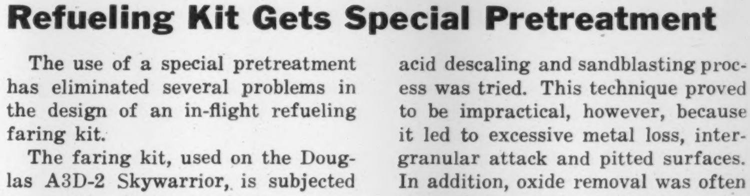
However, several problems developed: 1) precipitation annealing caused formation of a tenacious oxide scale; 2) decarburization was unpredictable; and 3) retention of austenite on the 0.04-in. thick metal varied from about 21 to 34%.

To overcome these problems, an acid descaling and sandblasting process was tried. This technique proved to be impractical, however, because it led to excessive metal loss, intergranular attack and pitted surfaces. In addition, oxide removal was often incomplete and there was danger of hydrogen contamination.

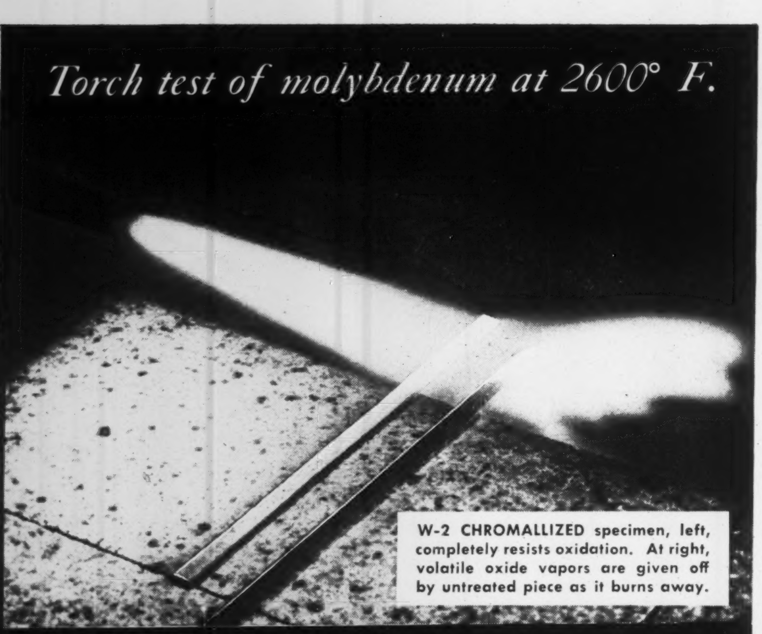
The solution

The solution to the problem was a special pretreatment process offered by Turco Products, Inc. Basically, the process involves the application of a coating to the metal surface before heat treatment, and then the removal of the coating (and scale) in a subsequent descaling bath.

According to Turco, the following advantages resulted from the pretreatment: 1) higher yield and tensile strengths, and improved ductility; 2) austenite retention reduced



Photomicrograph *of uncoated sample (left) shows 30% retained austenite (shown as large white grains above black surface boundary); coated sample (right) shows considerably reduced (7%) austenite retention.*



Torch test of molybdenum at 2600° F.

W-2 CHROMALLIZED specimen, left, completely resists oxidation. At right, volatile oxide vapors are given off by untreated piece as it burns away.

CHROMALLIZING
FOR METAL PROTECTION
AT JET-HOT TEMPERATURES

Improve oxidation and thermal shock resistance of metals used in jet engines and similar superheat applications with CHROMALLIZING. This patented method of diffusing chromium with other elements into the surface provides an alloy case which is integral with the base metal. It can't peel or flake; the chromium and other elements diffuse uniformly into recesses, pores, cracks and even blind holes.

Alloy	Usual Operating Temperature	Operating Temperature of CHROMALLIZED Alloy
Iron Base (including stainless steels)	1500° F	SA CHROMALLIZED 310 and 321 stainless steels show no failure after 18 hours at 1950° F in an atmosphere containing lead bromide and lead sulfide.
Nickel Base	1800° F	U CHROMALLIZED nickel base alloys are unattacked after 200 hours at 2000° F.
Cobalt Base	1800° F	SAC CHROMALLIZED cobalt base alloys are unattacked after 150 hours at 2200° F.
Molybdenum	Over 2000° F	W-2 CHROMALLIZED molybdenum shows no failure after 400 hours at 2350° F, after 48 minutes at 2800° F, and after one minute at 3400° F.

For technical information write to:

Chromalloy corporation
450-E TARRYTOWN ROAD · WHITE PLAINS, NEW YORK
WHite Plains 6-0020

Chromalloy Corporation Divisions

- PROPELLEX CHEMICAL DIVISION, EDWARDSVILLE, ILLINOIS
Propellants, cartridge actuated devices, explosives and special chemicals.
- ELYRIA FOUNDRY DIVISION, ELYRIA, OHIO
Quality gray iron castings.

For more information, turn to Reader Service card, circle No. 460

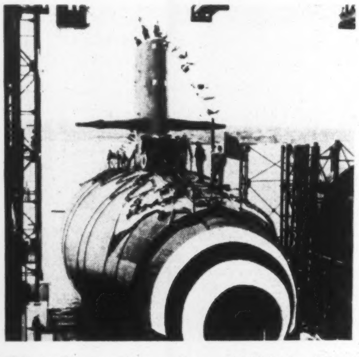
to less than 7%; 3) elimination of carburization and decarburization; 4) descaling time reduced 50%; 5) sandblasting eliminated; 6) metal removal minimized; 7) pitting eliminated; and 8) hydrogen contamination and intergranular attack minimized.

Urethane Foam Fills Voids in Atomic Subs

The change from traditionally used pitch and pine to urethane foam has resulted in a number of advantages in the design of atomic submarines.

According to Nopco Chemical Co., the foam, which is used to fill nonfunctioning cavities and structural voids, has trimmed more than 8½ tons from the weight of each submarine. The foam has an elastic memory and deflections resulting from pressure changes neither distort it permanently nor break its bond to boundary surfaces. In addition, unlike pitch and pine, urethane is not affected by salt water, will not crack when frozen and doesn't get waterlogged.

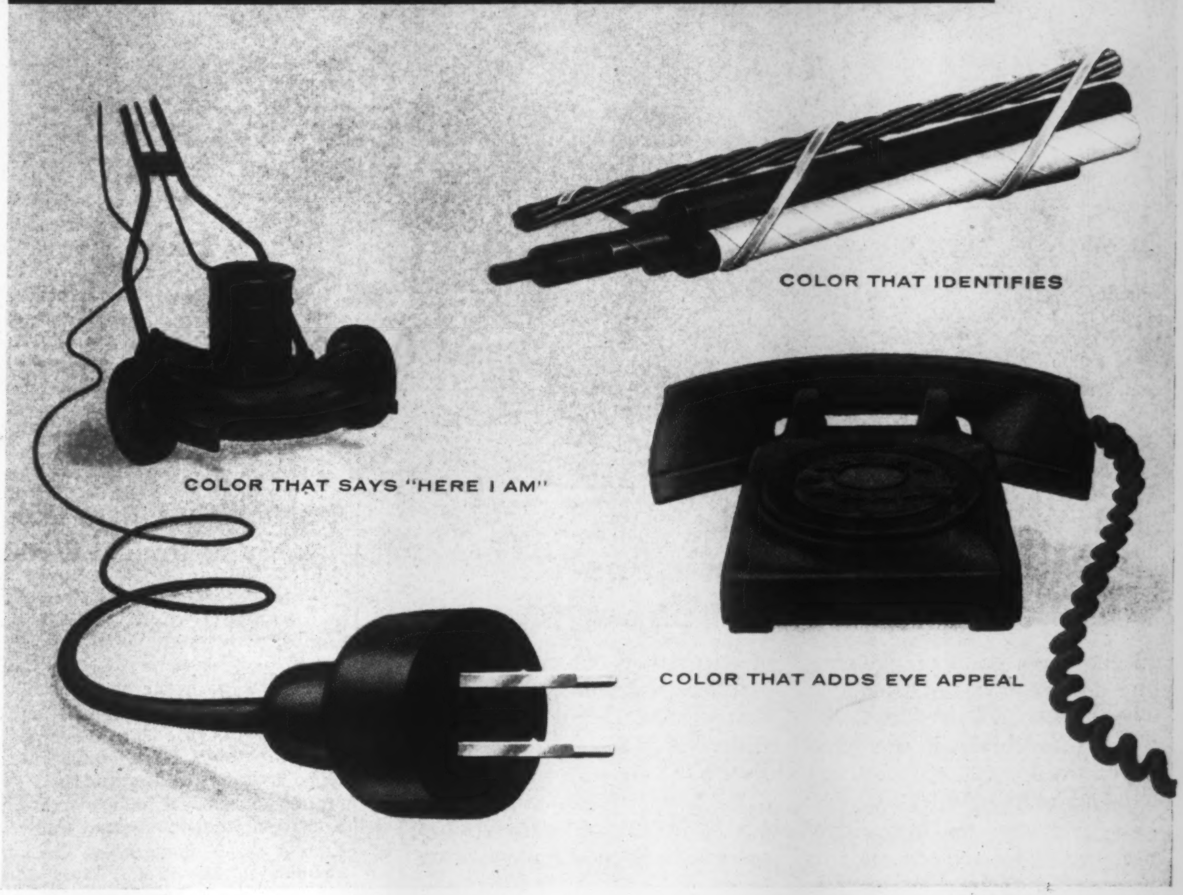
Most important advantage of the switch, however, is the ability of the new material to be foamed in place. Previously, interior structural members had to be specially shaped and placed to allow for insertion and fitting of the cut pine—and many desirable interior structures had to be avoided because they didn't permit sufficient access. In addition, the job took much longer



Atomic submarine *"Skipjack"—the Navy's newest—uses 20,000 lb of urethane foam.*

Naugatuck PARACRIL OZO

The oil-resistant, ozone-resistant nitrile rubber



Now! lasting **COLORS** in rubber wire jackets

A development of Naugatuck research makes it possible to combine in a vulcanized rubber wire jacket all these properties:

- Excellent resistance to ozone and outdoor "weathering"
- Outstanding heat resistance
- High abrasion resistance
- Excellent oil, grease and chemical resistance
- Fast CV extrusion

. . . PLUS PERMANENT BRIGHT COLORS

In addition to the suggested uses, you will think of dozens of other applications where wire jacketing with all these properties can serve either an aesthetic or utilitarian purpose.

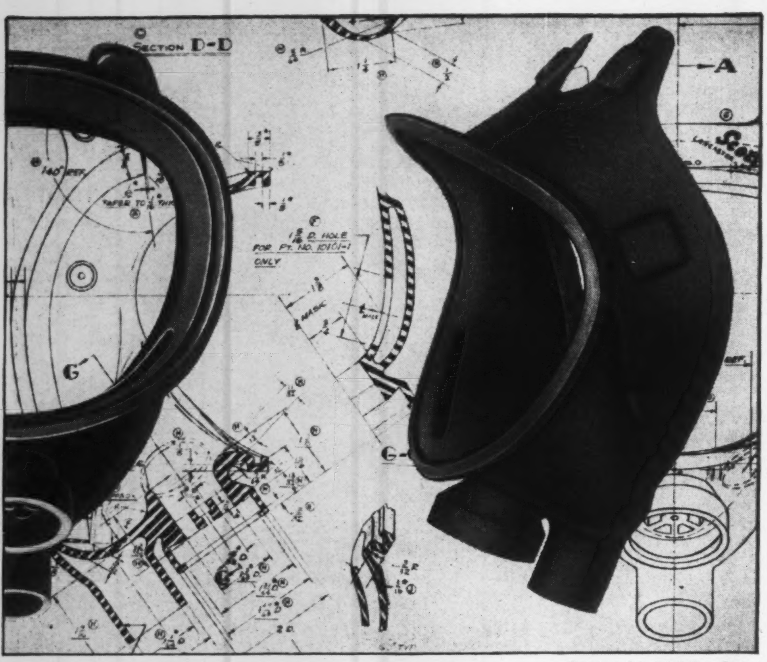
One of Naugatuck's technical representatives will be happy to discuss with any prospective user the formulation of the Paracril® Ozo compound which makes possible this combination of properties . . . not only in wire jacketing but also in shoe soles, hose jackets, weather stripping and other vulcanized rubber products.

Naugatuck Chemical

Division of United States Rubber Company
541P Elm Street
Naugatuck, Connecticut

Rubber Chemicals · Synthetic Rubber · Plastics · Agricultural Chemicals · Reclaimed Rubber · Latices · CANADA: Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario · CABLE: Rubexport, N.Y.

For more information, turn to Reader Service card, circle No. 507


Courtesy Scott Aviation Corp.

New Molded Profile Reveals Techniques for Better Rubber Specs

In the early stage of planning and design, it was questionable whether this face mask could be molded in rubber—in one piece—practically, yet economically . . . and here's why.

It calls for an ingeniously designed and machined mold to provide for facial contours, air inlets and outlets, undercuts, feathered edges, valve mounts, fastenings, etc.—one of the hardest-to-fill cavities ever encountered. Also, the rubber must be compounded to flow freely inside this complicated form and still maintain its knitting qualities. How was this accomplished?

While the mask was still in the design stage the customer realized the importance of consulting a rubber specialist. From this conference came an exchange of suggestions which led to a practical and functional design that permits molding these masks with unusual speed and economy. Here's the idea.

While a job is still on the drawing board consult with rubber specialists. Suggestions can often be made to eliminate high tooling costs or high priced compounds. End results give you better rubber parts, better performance and lowest cost. Regardless of how simple or complex your rubber needs may be call Continental—specialists since 1903.

Engineering catalog.
In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in RUBBER
engineered by CONTINENTAL

CONTINENTAL RUBBER WORKS • 1985 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 481

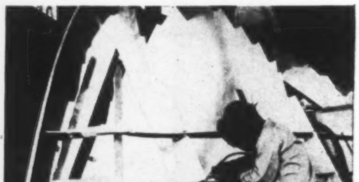
because the pitch poured into one side of a given area (e.g., a rudder or diving plane) had to set before the other side could be filled.

The foam is presently being used in the atomic submarines "Skipjack," "Triton," and "Scorpion," all made by the Electric Boat Div., General Dynamics Corp. About 20,000 lb of the high density foam (20 lb per cu ft) are used in each submarine. According to Nopco, although the urethane foam costs more than an equivalent weight of pitch and pine, the difference is offset by reduced labor costs and elimination of replacement due to deterioration.

Welded Aluminum Boat Speeds in Rough Water

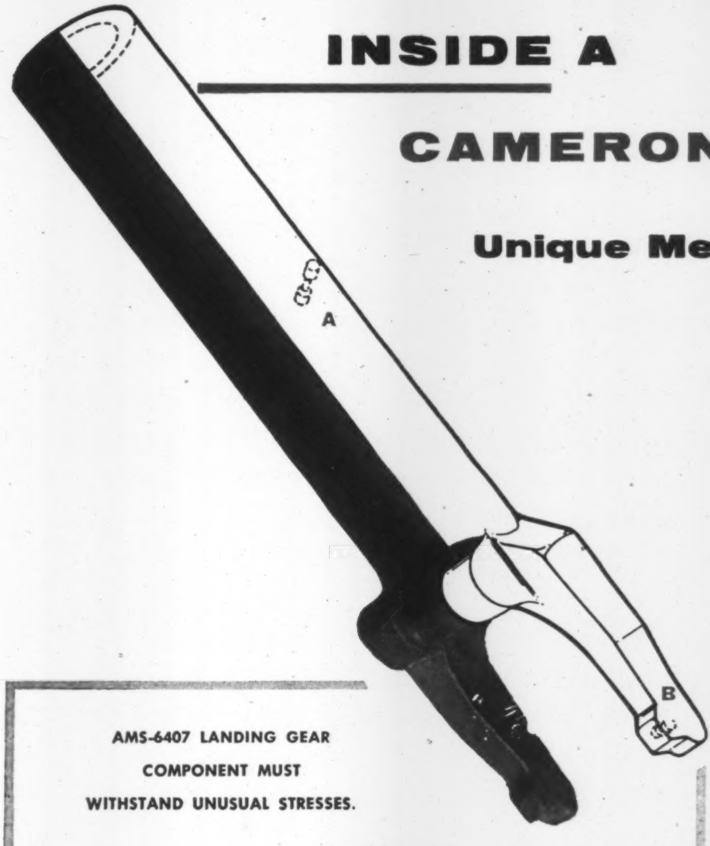
An all-welded aluminum boat has been developed which is said to be capable of maintaining high speeds (38-40 mph) even in 3½-ft waves.

The new boat, fabricated of aluminum alloy 5456, is said to be more maneuverable in rough water than any other high speed vessel of its type. According to Higgins, Inc., the craft's exceptional maneuverability is achieved by an unusual hull design. A series of steps are cut into the outside edge of each of the 52-ft boat's frames, giving a sawtoothed appearance. Cold formed 5456 aluminum plate is then fitted into the corresponding notches of each frame and welded by the inert gas consumable arc method. The result is a bottom with multiple lengthwise steps which deflect water away from the hull and provide cushioning for


Sawtooth frame *is welded by inert gas consumable arc method.*

INSIDE A CAMERON FORGING

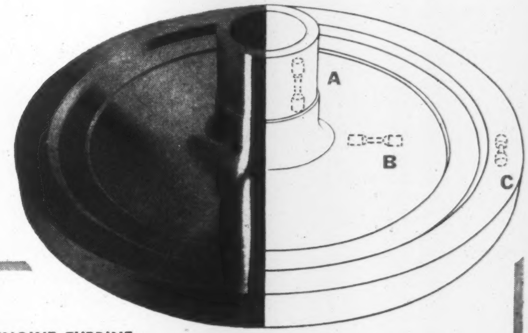
Unique Metallurgical Properties



AMS-6407 LANDING GEAR COMPONENT MUST WITHSTAND UNUSUAL STRESSES.

Typical Properties

		Tensile Strength	Yield Strength	Elon-gation	Reduction of Area Transverse
A	Tube, Transverse	236,000	203,000	12.7%	45.1%
B	Fork, Transverse	233,000	205,000	10.6%	31.9%



A-286 JET ENGINE TURBINE WHEEL OF SPECIAL ALLOY MEETS UNUSUAL DEMANDS.

Typical Properties

		Tensile Strength	Yield Strength .2% Offset	Elon-gation	Reduction of Area
A	Hub, Longitudinal	158,000	117,000	22.2%	40.0%
B	Web, Radial	159,000	116,000	21.3%	40.0%
C	Rim, Tangential	162,000	117,000	20.3%	39.7%

UNIFORMLY FINE GRAIN SIZE and uniformly high properties from center to surface are characteristic of the Cameron technique. Intricate, unusual, or conventional shapes are produced in a single heat.

INCREASED TRANSVERSE DUCTILITY—several times above normally expected values. Transition from billet to final shape results in movement of metal under high internal pressure.

HIGH ULTRASONIC STANDARDS are consistently met by internal working of the metal which breaks up segregated material inherent in the center of steel and high density alloys.

PARTING LINE PROPERTIES—The totally enclosed method of forging, eliminating a flash line, avoids flash line magnetic indications and the localizing effect of the flash grain on transverse, fatigue, and stress rupture properties.

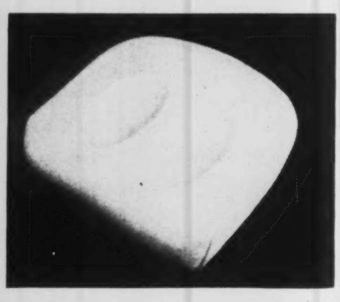
Extreme service components for airframes, jet engines, guided missiles and a wide variety of other end uses are finding a solution in the Cameron split-die forging process. If you have a problem . . . call, write or come by

Cameron
IRON WORKS, INC.

SPECIAL PRODUCTS DEPARTMENT
P. O. Box 1212, Houston, Texas

For more information, turn to Reader Service card, circle No. 561

SEATING QUESTION?



Reynofoam Can Answer It

There's excitement in industry today over a revolution in seating. Seating for automobiles, tractors, buses — and furniture.

Reynolds Chemical Products Company has pioneered the development and perfection of urethane foam as low-cost, high-comfort seating.

Today two Reynolds Chemical plants are in full production of Reynofoam* seating—and equipment to create a third production line will become operational at Reynolds Chemical this month.

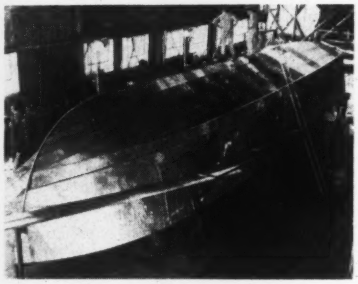
If you have a seating problem, don't you owe it to yourself to bring it to the people who know foam — and seating — best?

REYNOLDS CAN MOLD IT—IF ANYONE CAN!

REYNOLDS CHEMICAL PRODUCTS COMPANY

Whitmore Lake, Michigan • Phone HIckory 9-9361
DIVISION OF STUBNITZ GREENE CORP.

For more information, turn to Reader Service card, circle No. 527



Polyhedral bottom *enables vessel to maintain 40 mph in 3½ ft waves.*

All-aluminum boat *is claimed to be more maneuverable in rough water than any other high speed boat.*

the downward movement of the boat's bow.

According to Aluminum Co. of America, aluminum alloy 5456 was selected because it is "the strongest alloy available in the aluminum-magnesium series, is light in weight, and has good welding qualities and excellent resistance to sea water corrosion." Approximately 10 tons of sheet and plate ranging in thickness from 3/16 to 1 in. were used. The boat carries 30 passengers and a crew of two.

Largest Nylon Cylinder

The 21-ft, 700-lb cylinder shown in the photo on p 224 is said to be the largest nylon one-piece shape ever manufactured.

Such cylinders, produced with 16-in. o.d.'s and 13-in. i.d.'s, are designed primarily for use as rollers in embossing or coating paper, textiles, artificial leather and other sheet materials. Because nylon will not gall or scratch prefinished metal surfaces, the cylinders are also suggested for use as roller coverings in metal strip forming.

For more information, circle No. 517 ➤

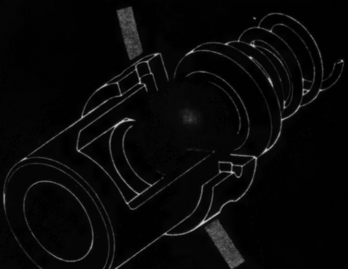
PERFECT SURFACE . . . EXTREME HARDNESS . . . LOW COST

—all this and more, with LINDE Sapphire!

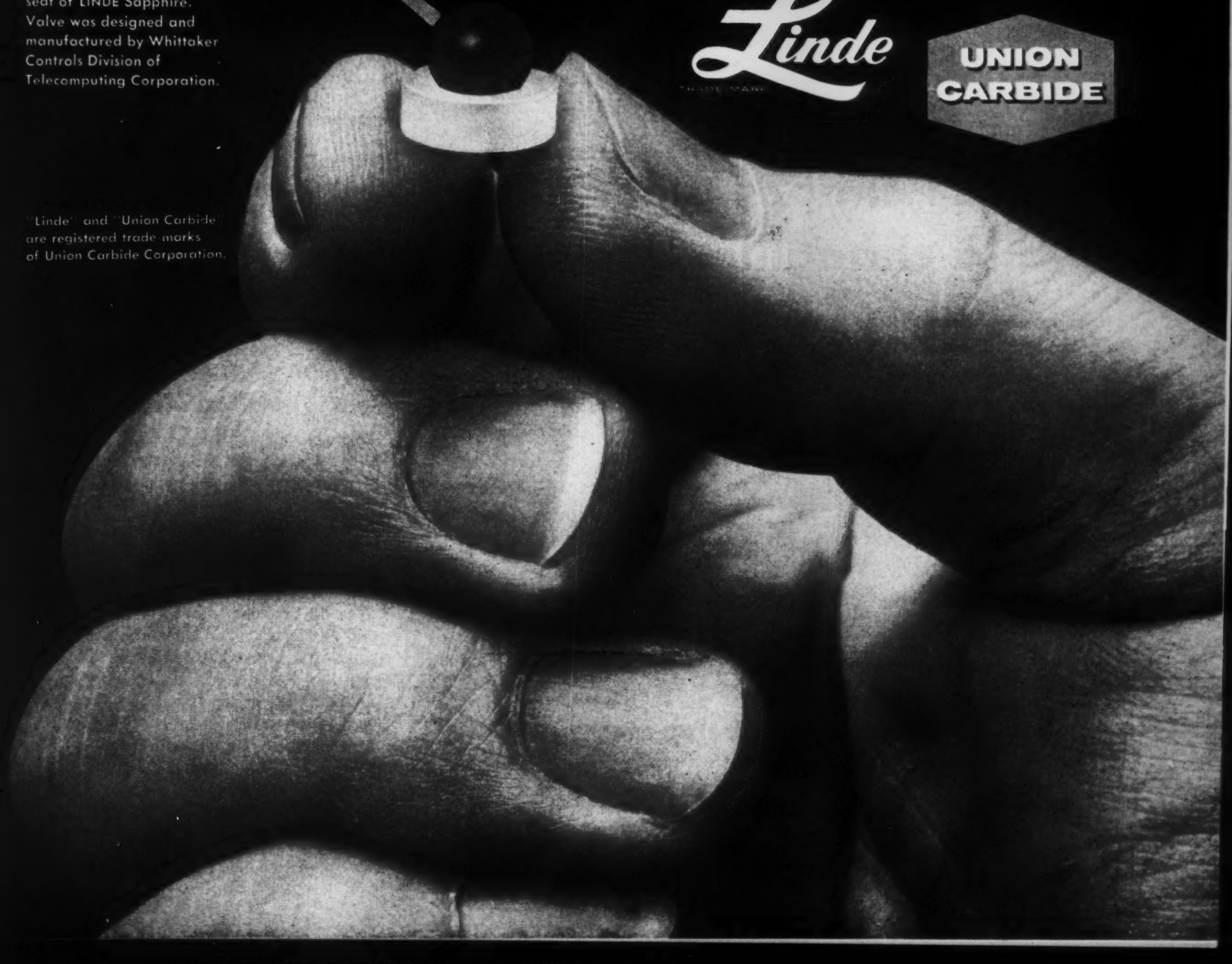
To assure dependability under the most severe conditions, tiny valve poppets and seats of pilot relief valves for space vehicle tanks built by Whittaker Controls are made from LINDE Sapphire. LINDE Sapphire was selected over other materials for this critical use because of its perfectly smooth surface, extreme hardness, and relatively low cost. Other advantages are resistance to corrosion and fast deliveries from LINDE.

Among other properties of LINDE Sapphire are zero porosity, great strength at elevated temperatures, and a high melting point of 2040° C. LINDE Sapphire is transparent, may be clear or red. It is easily sealed to metals or ceramics and has excellent IR transmission characteristics.

LINDE Sapphire is supplied in the form of balls, rods, tubes, domes, and special shapes to order. For more information, write Crystals Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.



Pilot section of this pressure relief valve has poppet ball (red) and seat of LINDE Sapphire. Valve was designed and manufactured by Whittaker Controls Division of Telecomputing Corporation.



Linde
TRADE-MARK

UNION CARBIDE

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Shown 1/16 actual size

HACKNEY shapes meet needs of a changing world

Missiles! Moons! Rockets! Old, familiar words that mean new, unfamiliar problems for design and production engineers.

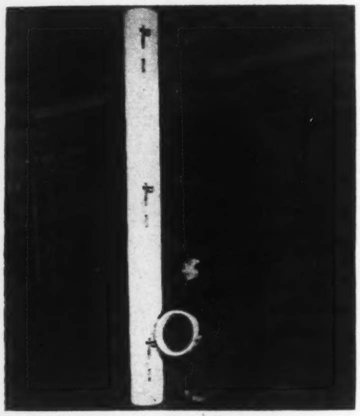
They are challenging words, too, to our engineers who are called upon to apply the *Hackney Method*—deep drawing shapes and shells from cold metals—to provide practical, economical answers to Space Age engineering problems.

The photo above shows how *Hackney Methods,* familiar for many years to engineers in many industries, can produce deep drawn, seamless parts for missiles which have maximum strength with minimum weight.

For detailed information about *Hackney Methods,* and their application to your design and production problems, write:

Pressed Steel Tank Company
Manufacturer of Hackney Products
1442 South 66th Street, Milwaukee 14, Wisconsin
Branch offices in principal cities

For more information, turn to Reader Service card, circle No. 448



Nylon rollers *for embossing or coating paper, textiles, etc. are said to be the largest monolithic nylon shapes ever made.*

Other applications for the cylinders include: large journal bearings, tires for industrial materials handling equipment, and housings for circuit breakers. According to Polymer Corp., the nylon rollers offer excellent abrasion resistance, resilience and surface characteristics.

Details on the manufacturing process have not been revealed. However, Plymer says that with slight modifications in existing equipment cylinders can be produced with o.d.'s up to 48 in. and with virtually any wall thickness greater than 1 in.

90-Ton Weight Saving Attributed to T-1 Alloy

The decision to use T-1, a low alloy, high yield strength steel, instead of ordinary carbon steel in the fabrication of a massive test chamber for nuclear-powered aircraft engines has resulted in a weight saving of 90 tons.

The gigantic pressure vessel measures 40 ft long and 12½ ft in dia and is designed to contain internal pressures as high as 250 psi. When completed and installed at the Connecticut Aircraft Nuclear Engine Laboratory, it will weigh 160 tons. According to Lukens Steel Co., supplier of T-1, if made of carbon steel it would have weighed 250 tons.

The test chamber is composed of

WANTED: more "wife savers"

UNILOY
STAINLESS STEELS

Modern homemakers know that dishwasher detergents cannot mar the gleaming beauty of household items made of stainless steel. That's why sales are soaring in new and growing markets for these attractive, enduring, easy-to-keep-clean "wife savers."

For uniform high quality, lustrous finish and ease of fabrication . . . always specify Uniloy Stainless Steel.

UNIVERSAL CYCLOPS
STEEL CORPORATION
BRIDGEVILLE, PA.

STAINLESS STEELS • TOOL STEELS • HIGH TEMPERATURE METALS

For more information, turn to Reader Service card, circle No. 509

WORLD BESTOS
BRAKE LINING
. . . any *shape* . . . any *size* . . . any *friction*
to meet your most exacting requirements!

ROUND
as for
Race Cars
INTRICATE
as for Industrial
Brakes
TINY
as for small Precision Assemblies
BIG
as for giant
Forming
Presses

- World Bestos is currently helping many manufacturers solve difficult braking problems with special friction formulas that assure dependable stopping power, non-fading performance and extra long life.

World Bestos offers extensive research and development facilities and more than 30 years' specialization in friction material manufacture. Modern, high-capacity plant assures on-schedule delivery.

- **Write for new Industrial Brake Folder . . . or let us know your specific requirements. Send prints and specifications if possible. Engineering assistance available.**

WORLD BESTOS NEW CASTLE INDIANA

DIVISION OF THE
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TIRE & RUBBER CO.

Industrial and Automotive Brake Blocks and Linings · Transmission Linings · Special Clutch Facings · Vibration Controls · Sheet Packing

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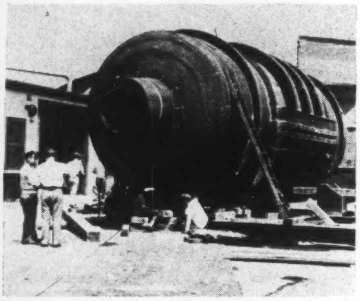


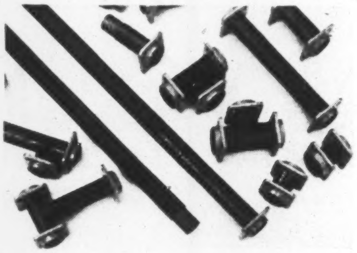
Test chamber *uses T-1 alloy throughout.*

shell walls made of 1¼-in. thick T-1 plate reinforced with 1½-in. thick T-1 rings. The shell walls are composed of three cylindrical sections, each having a single longitudinal weld.

Largest Steel Closure Formed in One Stroke

What is believed to be the largest, thickest and heaviest pressure vessel closure ever made at a single stroke by die-forming was pressed from a 58,646-lb circular plate of SA-212 Grade B carbon-silicon steel.

(continued on p 228)



Corrosion-proof pipe — Shown above are some of the types and shapes of pipe now being extruded of impervious graphite. According to Falls Industries, Inc., the material is unaffected by practically all corrosives, except for a few highly oxidizing agents. The pipe is recommended for use at temperatures up to 340 F, at pressures up to 75 psi. The pipe is supplied in standard lengths of 72 in.

For more information, turn to Reader Service card, circle No. 362

SINKO MOLDED
Cabinet Rollers

The Cabinet Drawer Rollers pictured were molded of Sinko ZYTEL for a leading manufacturer of fine Kitchen Equipment. This long-wearing plastic material was selected after a series of exhaustive tests had proven its superiority over many others.

Moving parts made of ZYTEL are quiet in operation even after long exposure to continued wear.

ZYTEL is the new tradename for Du Pont nylon resin.

Investigate TODAY the many advantages Sinko ZYTEL offers you . . . resistance to wear and to shock loads, to moisture, chemicals and to temperature; and its smooth-gliding, self-lubricating properties.

Our services include Design and Engineering, Mold Construction, Metal-plastic Assemblies, 2 and 3 color Plastic Spraying and Painting, Hot Stamping, Vacuum Distillation Plating, Fabricating and Assembling.

WE MOLD ALL THERMOPLASTICS—2 to 175 oz.

Sinko MANUFACTURING and TOOL CO.
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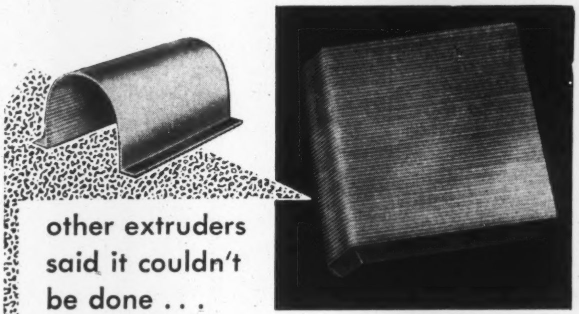
Offices in Principal Cities Throughout the United States



other extruders said it couldn't be done . . .

GENERAL DID IT!

The manufacturer of heaters wanted a hearth bottom — a fluted, gold-anodized aluminum extrusion. Specifications called for a 7" x .050" shape. Extruders with presses that take 8" diameter billets said it couldn't be done because of the thinness, too great a reduction ratio.

G.E.I. engineers came up with the extrusion, on a 5" press! The shape is extruded half round, then straightened, notched and bent, holes punched, and finally gold-anodized.

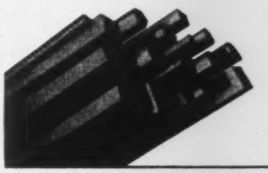
If you have a problem involving aluminum fabrication, finishing or extrusion, why not take it to General, pioneers in developing new uses for extruded aluminum.

GENERAL EXTRUSIONS, INC.
4040 LAKE PARK RD., YOUNGSTOWN, OHIO
Mill Representatives at St. Louis, Detroit, Pittsburgh, Cincinnati, and Chattanooga

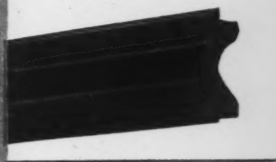
Consult your classified phone book under Aluminum Products

For more information, turn to Reader Service card, circle No. 394

Brass & Bronze Free-Cutting Rods



Extruded Brass Shapes

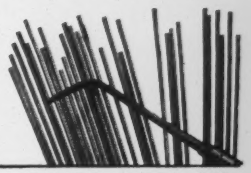


'Tru Shaft' Bronze Boat Shafting

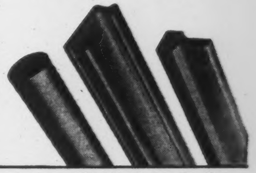
Brass Wire

Titan
quality metals

Bronze Welding Rods



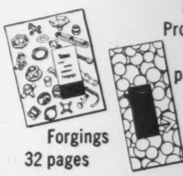
Brass & Bronze Forging Rods



Brass, Bronze & Aluminum Forgings

Brass Pressure Die Castings

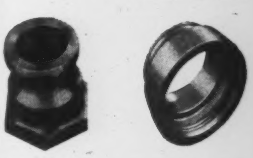
Get these 2 free booklets!
Write us on your letterhead



Rod Products 24 pages

Forgings 32 pages

Machined Parts



Titan® METAL MANUFACTURING COMPANY

Subsidiary of Cerro de Pasco Corporation
Bellefonte, Pa. Newark, Calif.

OFFICES AND AGENCIES IN PRINCIPAL CITIES

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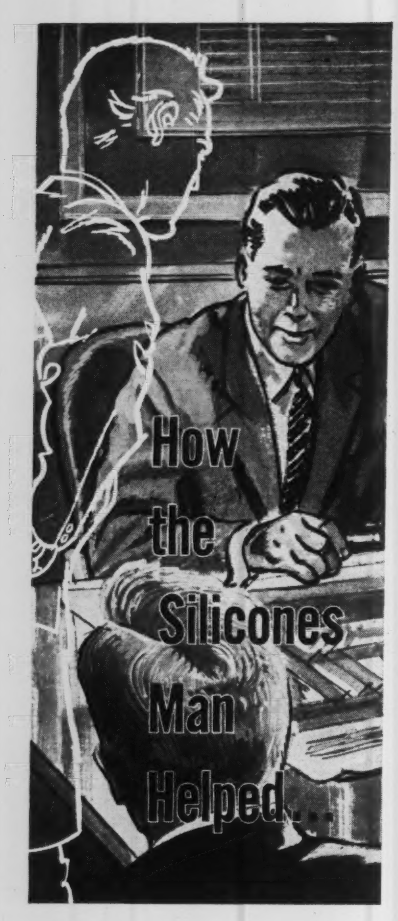

RUBBER THAT TAKES A 350 F PINCH

The rubber-covered pinch rolls used in a vinyl sheet laminating machine had to be changed every two weeks. The 350° F. operating temperature and high pressure caused the rubber to crack, become hard and glazed, making frequent regrindings necessary. After a few regrindings the rolls had to be completely resurfaced. Since the press was in operation around the clock, these delays were costly.

The Silicones Man suggested a springy, heat-resistant silicone rubber be used to surface the hard-working rolls. This was done ... and the rolls are now giving full-time, profitable service. There hasn't been a shutdown for renewal after more than eight months.

The delighted manager of the laminating plant says the silicone rubber resists hardening, cracking, glazing, and oxidation ... unlike the old type of rubber surfacing. And it's saving his company considerable money, despite the higher cost of the silicone rubber.

NEW WRINKLE IN ANTI-WRINKLE PROCESSING

Chemical treatment of wearing apparel to make it hold creases and resist wrinkling also brought wrinkles to the brows of processors. In many cases, the resins used to make a fabric crush-proof also made the fabric too stiff and harsh feeling. However, many of the softeners available created an additional problem. Crush-proof fabrics so treated tended to pick up soil during laundering.

To help resolve this situation, UNION CARBIDE developed a silicone emulsion softener that works well with stiffeners, giving fabrics a better hand and eliminating the tendency of wet cloth to pick up or retain soil. The silicone emulsion is not harmed by chlorine, doesn't yellow with age, and won't water spot.

Other advantages of the new silicone emulsion lie in its ability to provide fabrics with greater durability and tear strength, better abrasion resistance, and non-scorching properties.

FAST, ACCURATE CONTROL OF FOAMING SYSTEMS

Undesirable foaming can easily be controlled with a new silicone antifoam fluid, now being offered to processors by UNION CARBIDE. Only a few parts per million of the antifoam, called SAG, are needed in many systems to assure complete quiescence. Processing time is considerably reduced, providing fuller utilization of production capacity.

Silicone antifoam fluid can be used full strength, or dispersed with a solvent, or pre-blended with a foaming component. For aqueous solutions, it may be introduced by first mixing with a water-miscible solvent. An example of this application is in reducing the foaming in brackish water used for boiler feed.

Its chemical inertness and oxidation resistance extend the effectiveness of silicone antifoam over long periods. Since it is low in volatility, the antifoam works well at elevated temperatures. It is not irritating to the skin of those who work with it.

The Silicones Man is accustomed to helping solve problems like these ... and he may be able to help you, too. For background information on these and other applications, write Dept. EM-0902, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE TRADE-MARK SILICONES

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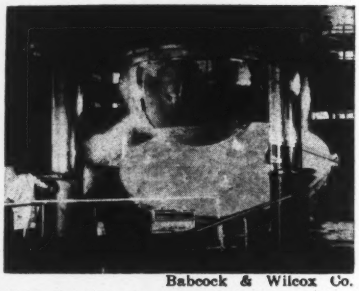


Babcock & Wilcox Co.

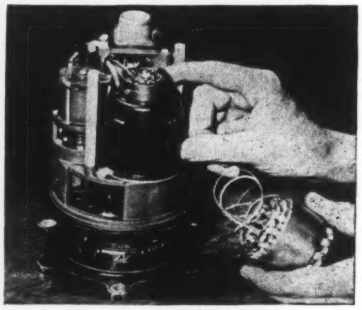
***Steel slab** is moved into position between dies of press.*

Before forming, the surface of the plate, which measures 15 ft in dia and 7 3/16 in. thick (see photo), was clad with a 0.019 in. layer of 304 stainless steel. To make the plate workable, it was heated approximately 6 hr to bring the temperature to 2000 F. A force of approximately 3300 tons was exerted to form the plate into a hemispherical-shaped head with an 11-ft, ⅝-in. o.d. and a 9-ft, 9-in. i.d.

The closure will be used as the bottom head of a nuclear reactor vessel which will generate steam for electricity at the Indian Point, N. Y. station of Consolidated Edison Co.

Reinforced Silicone for Motor Insulation

The switch from a conventional organic insulation to glass-reinforced silicone rubber slot liners impregnated with a silicone varnish has eliminated the necessity of constantly rewinding burnt out auto pilot



***Silicone-insulated motor** operates at temperatures in the range of 300 F.*

Here are five ways to use versatile-flexible

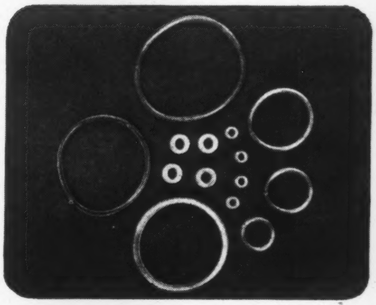
TYGON®

AS TUBING OR HOSE to pipe taste-sensitive liquid foods or corrosive chemicals. Tygon Tubing is glass-clear, flexible as a piece of string, resistant to acids and alkalies, non-toxic, sterilizable, and is made in bores from 1/16" to 4".

AS A PAINT to protect plant and equipment from attack by corrosive fumes and gases. Applied by brush or spray, Tygon air dries quickly to form a tough impermeable plastic skin that shrugs off acids, alkalies, oils, water and alcohols.

AS A HEAVY-DUTY LINING to protect the interior of pickling, plating, chemical processing and storage tanks from destruction by corrosive solutions. Easier to install than rubber linings, Tygon can be applied to tanks of any size or shape.

AS A CORROSION-RESISTANT GASKETING. Tygon shows no chemical deterioration with age. Gaskets remain flexible and tight, unaffected by weather or exposure to chemicals. Tygon gaskets are available in an almost unlimited size range.



AS MOLDED ITEMS. Tygon's toughness, durability and flexibility, coupled with staunch chemical resistance, offer pronounced performance characteristics for grommets, washers and molded mechanical goods items in virtually any shape.

WRITE TODAY for the TYGON PORTFOLIO. *Pertinent data and technical characteristics of the various Tygon compounds to enable you to determine just how you can use Tygon most advantageously. Free, on request. Address Dept* MM-559

Few materials offer more versatility in use than the Tygon series of thermoplastics. In whatever form they are used: tubing, coatings, sheet materials or molded goods, the Tygons are characterized by superb resistance to chemical attack. It shrugs off with equal ease both acids and alkalies. If corrosion is a problem in any product you make, Tygon may prove the perfect answer.

OUR 100th YEAR

PLASTICS AND SYNTHETICS DIVISION

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PUREBON

SELF- LUBRICATING

LOW FRICTION

STABLE AT HIGH TEMPERATURES

carbon-graphite especially designed for mechanical applications

Sliding or rotating components compounded and molded of Purebon are self-lubricating; the material is unusually stable at high temperatures. It is readily machinable, chemically inert, light weight, low cost when moldable to size. Send prints or parts for prompt quotation.

REQUEST BULLETIN NO. 59 OR SEE SWEET'S PRODUCT DESIGN FILE

PURE CARBON CO., INC.
446 HALL AVE., ST. MARYS, PENNSYLVANIA

For more information, turn to Reader Service card, circle No. 474

servo motors used to actuate rudder, elevators and ailerons in certain types of aircraft.

According to United Airlines, the motors are totally enclosed and nonventilated—to obtain the absolute minimum in size and weight—and operate at temperatures in the range of 300 F, or about 80°F above the serviceable limit for organic insulation. Failures previously occurred after about 1000 hr, and although only the performance of the auto pilot was affected, repair costs averaged about $3400 per year.

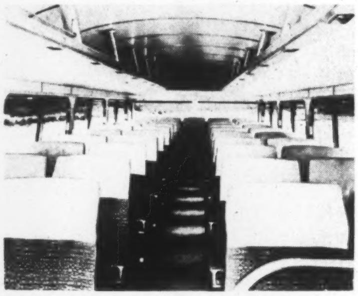
The new silicone rubber insulation raised materials costs from $3 to $16 per motor; however, not one failure has occurred since the new motors were installed over a year ago.

Vinyl-Clad Aluminum Reduces Bus Cost

Vinyl-clad aluminum is now being used extensively for interior paneling of buses.

According to Clad Rex Corp., the new paneling eliminates the necessity for painting the interiors of coaches, thus eliminating the time-consuming job of masking, papering and running the bus through a drying oven. The material can be sheared, formed and hammered without the use of protective coverings; requires no maintenance; is easily cleaned; and resists scratching, marring, peeling, chipping, cracking or fading.

The paneling is used to cover the entrance area, the entire dashboard section, window frames, luggage racks, roof and wainscotting.



***Interior paneling** of bus uses vinyl-clad aluminum.*

Chicago Daily Tribune
AMERICAN METAL MARKET
STEEL
Metal Progress
American Machinist
DIAMOND WHEELS
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Breakthrough in Tungsten Fabrication Promises Wider Use of Pure Metal
Breakthrough in Tungsten Fabrication

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"Up to now, I've only dreamed of being able to use *pure* tungsten . . . now it's a reality." This is a typical reaction to the news of Fansteel's breakthrough in the fabrication of tungsten.

It opens endless possibilities for using tungsten in any number of products—whether it's a spectacular missile, or a down-to-earth consumer item. Now . . . tungsten—with its melting point of 6152° F., highest of all metals, with its terrific strength at high temperatures, with its outstanding density of .697 lbs./cu. in.—can be exploited to the fullest.

Because Fansteel can now fabricate *pure* tungsten into almost any conceivable shape by spinning, deep drawing, hot extrusion or forging, the design engineer can count on tungsten . . .

- —for greater reliability and longer life
- —for even greater miniaturization
- —for highest strength at extreme operating temperatures

Want to explore the possibilities of adapting tungsten to *your* product? Fansteel engineers will be glad to work with you. Just send print, part sample or call in your Fansteel representative.

Only your imagination will determine what lies ahead in the uses of tungsten.

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Take full advantage of the superior electrical and physical properties of High Alumina and Steatite ceramics. Let CENTRALAB provide you with complete assemblies.

The specialized techniques of close tolerance ceramic-to-metal fabrication are daily routine at CENTRALAB. You can eliminate production assembly problems and at the same time achieve superior products by relying on years of expert knowledge and unequalled facilities for engineering ceramics.

CENTRALAB can handle intricate, precision assemblies involving machining of ceramics or metals to ±.00025, metalizing of ceramics, cementing, riveting, soldering, plating, and stamping. Such assemblies are regularly produced in their entirety—from raw stock—in the CENTRALAB plant.

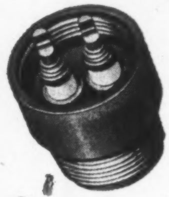
Write for your free copy of CENTRALAB'S Ceramic Design Handbook giving your detailed design data and complete electrical and physical specifications on High Alumina and Steatite ceramics.

VARIABLE CONDENSER SHAFT

Precision 95% High Alumina shaft and silver plated brass hardware assembled and machined to a Total Indicator Reading requirement of less than .002".

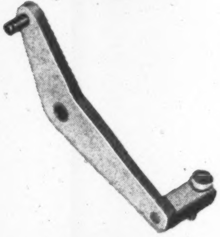
HIGH PRESSURE CONNECTOR

With eight critical metal to ceramic sealing areas, capable of withstanding a minimum of 3,750 psi. Copper plated stainless steel housing.



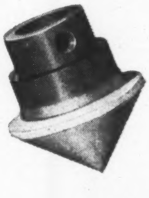
TUNER COUPLING ARM

To hold center dimensions between riveted brass pivot and cemented phosphor bronze bushing, bushing is machined to a tolerance of ±.0005" or less. O-ring groove on pivot machined to .012" wide, —.000" + .002". Machined ceramic screw.



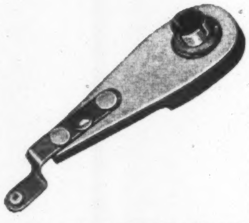
NON-FLOATING VALVE SEAT

Comprised of ceramic cone with surface finish of 3-5 helium light bands brazed to machined and copper plated bushing. After assembly, Total Indicator Reading of ceramic cone is less than .005".



CONTACT ROTOR ASSEMBLY

With riveted and soldered contact arm. Nickel plated brass bushing soldered to metalized ceramic. Tolerance —.000" + .001". on I.D. of bushing after slotting.



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News OF INDUSTRY

Powder Metal Contest

An awards competition for the best application of nonferrous powder metallurgy in product design has been announced by New Jersey Zinc Co. Purpose is to promote use of nonferrous powder metallurgy. Any new or redesigned product, assembly or component utilizing a structural or mechanical part made of brass or nickel silver powder is eligible. Contest closes June 30. For details, write to Awards Editor, New Jersey Zinc Co., 160 Front St., New York 38.

New Labs Study Materials

The following brief reports cover some of the latest research being conducted on engineering materials and processes:

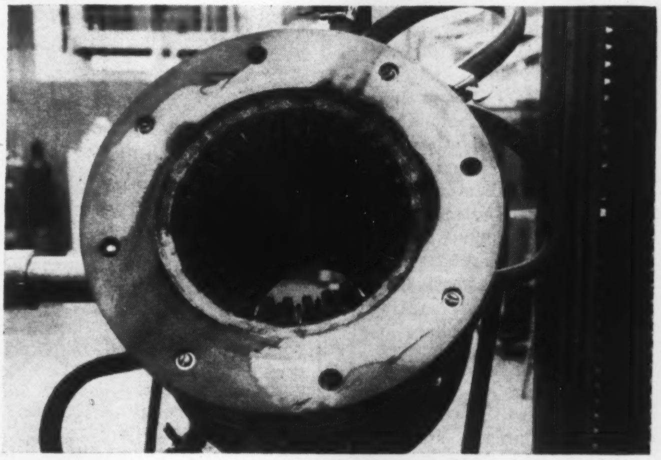
▶ An understanding of the effects of radiation on materials and equipment (and how to protect against it) will be the main goal of research in a new cobalt chamber installed by General Electric Co. in its General Engineering Laboratory.

According to GE, the lab will attempt to duplicate radiation in outer space to determine how space craft and people can be protected from cosmic bombardment. The laboratory uses radioactive cobalt to produce up to 500,000 r per hr. One of the objectives will be to gather information on how equipment will operate under moderate or low radiation doses over extremely long periods of time.

▶ A new forest products research center, devoted to the improvement of existing materials and development of new materials and products, has been put into operation by Olin Mathieson Chemical Corp. One of the laboratory's major objectives is to perform research aimed at the utilization of local hardwoods as a raw material. Other materials to be investigated include kraft paper products, pine lumber, hardwood flooring and treated lumber.

▶ The development of materials with special properties (such as high heat strength or low neutron absorption) for use in missiles, rockets and atomic energy will be the primary aim of a new research center established by Wolverine Tube Div., Calumet & Hecla, Inc. Materials being studied include molybdenum, zirconium, columbium, vanadium, tantalum, titanium and tungsten. Fabrication techniques under study include hot and cold extrusion, high

(continued on p 234)



Quick-heat furnace—To meet the ever increasing need for elevated temperature testing equipment, Boeing Airplane Co. has developed the unique quick-heat furnace shown above. According to Boeing, the furnace will reach 3500 F in 90 sec. To supply heat, 30 quartz heat lamps are arranged in a circle. A surrounding copper water-jacket cooling system prevents the lamps and connectors from melting and permits the lamps to be operated at over twice the manufacturer's rating—maximum power is boosted from 1000 to 2700 w per lamp. The inner surface of the furnace is gold plated for better heat reflection.

New SAMPE Chapter

Latest addition to the Society of Aircraft Materials and Process Engineers is the Mid-West Chapter, which covers the Dayton, Middletown, Richmond and Cincinnati area. The Society holds monthly technical meetings.

For further information, contact D. C. Perry, membership chairman, Research Laboratory, Armco Steel Corp., Middletown, Ohio.

Eastman 910 Adhesive

Eastman 910 Adhesive solves another production bottleneck

New Plastic Corporation, Los Angeles, manufactures light, attractive hammers as part of an all-purpose tool kit, called "Diligent Duchess," designed specifically for housewife or career girl.

To assemble the hammer, a molded plastic adapter on the end of the glass fiber handle is coated with a small amount of Eastman 910 Adhesive and immediately rammed into the steel forged head.

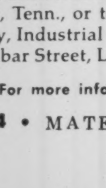
Within minutes, the bond is strong enough to permit packing for shipment.

The adhesive-bonded hammer withstands 300,000 blows successfully, indicating a service life expectancy three times normal.

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins *immediately*. With most materials, strong bonds are made in minutes.

What production or design problem can this unique adhesive solve for you?



Bonds Almost Instantly ...Without Heat, Pressure or Catalyst

For a trial quantity (1/3-ounce) send five dollars to Eastman Chemical Products, Inc., Chemicals Division, Dept. E-5, Kingsport, Tenn., or to Armstrong Cork Company, Industrial Adhesives Division, 9105 Dunbar Street, Lancaster, Pa.

For more information, circle No. 515

velocity forming, and spinning. Also under study is the development of new types of extended surface tubing.

- Research on materials and techniques required for thermoelectric cooling devices will be conducted at Battelle Memorial Institute. The basic objective of the study is the preparation of new compounds and investigations of their resistivity, thermal conductivity and thermoelectric power.

Special Courses on Engineering Materials

Here is another report on special courses on engineering materials being offered by leading universities and colleges:

Pennsylvania State University—*Reactors and Radioisotopes:* seminar covers use of nuclear reactors and radioisotopes in research and development. Discussion is aimed at analyzing individual problems (June 1-26); *Foundry Conference:* this year's biennial conference will cover gray iron, steel, malleable iron, nonferrous alloys, and sand and sand handling (June 25-27); *Management:* lecture and workshop sessions will provide engineers and scientists with skills in administration and human relations to prepare them for management positions. Subjects to be covered include: development of administrative skills; the role of management; leadership; motivation; communication; training; rating; and other human considerations (July 5-10).

University of Michigan—*Solid State Masers:* lectures will cover recent developments and present status of research in solid state masers. Subjects to be covered are: physics of paramagnetic substances, circuit as-

Design Show—See pp 21-29 for complete details on technical program, registration and exhibitors at the 4th Annual Design Engineering Show and Conference, May 25-28, Philadelphia.

Another Illustration of the High-Heat Stability of

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HEAT RESISTANT FINISH

USED ON THE NOSE CONE OF THE CHRYSLER REDSTONE MISSILE

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Proved in Large Scale Tests and Actual Missile Firings

Sicon possessed the high heat resistance necessary in these tests, whereas other finishes ignited and burned under simulated re-entry conditions. Sicon in aluminum or black withstands temperatures as high as 1000° F. Modern colors which retain color and gloss in the 500°F. range add sales appeal and longer life to consumer products. Write for new SICON bulletin.

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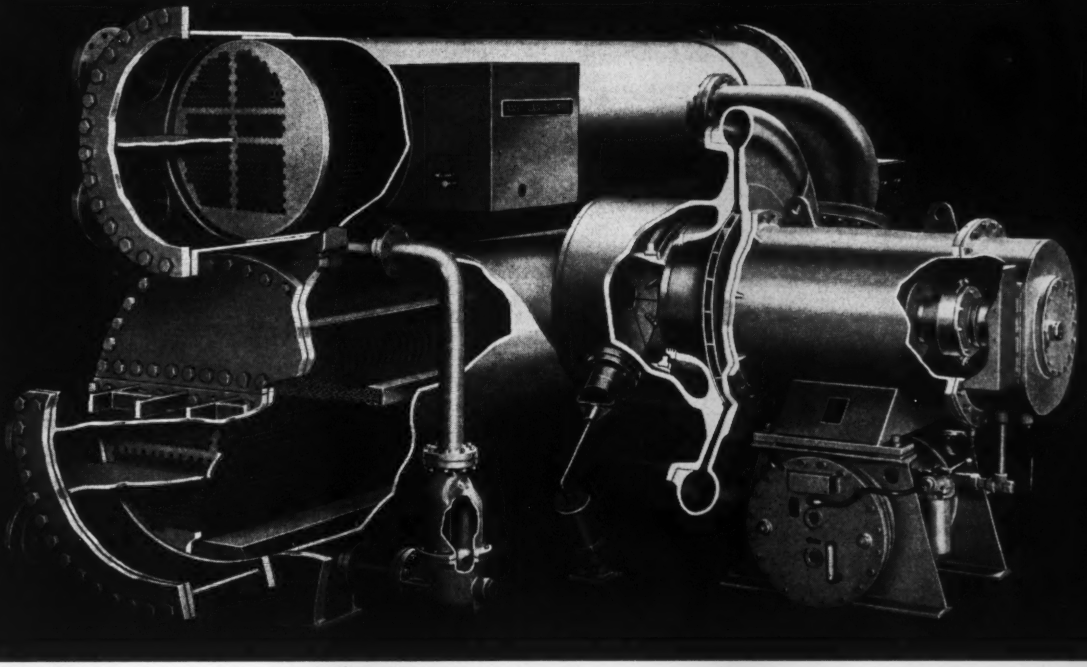

WOLVERINE TRUFIN® SAVES SPACE

provides more heat transfer surface

No finer proof of the space saving and heat transfer abilities of Wolverine Trufin Type S/T—the integrally-finned condenser tube—can be found than in its use by American-Standard Industrial Division, Detroit, Michigan.

American-Standard uses Trufin Type S/T in the evaporator and condenser tube bundles of Tonrac—its completely self-contained, hermetic, centrifugal, refrigerating machine. This single-level unit is widely-used to supply chilled water for air conditioning systems in public buildings, offices and industrial plants.

Wolverine Trufin Type S/T is of great value here, because its extended surface has approximately 2½ times as much outside surface area as ordinary, plain condenser tube. In units such as Tonrac this enables the manufacturer to pack greater heat transfer capacity into a given area thus reducing overall unit size.

If heat transfer efficiency is important to your company why not follow American-Standard's lead and specify Wolverine Trufin Type S/T for shell and tube condenser use. Write for more information or ask for the services of a highly-trained Wolverine Sales Representative.

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

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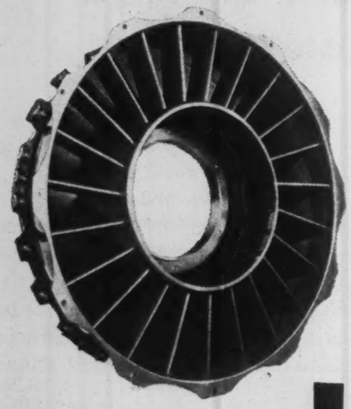

Typical Stalker fabrication. Nozzle assembly of nimonic alloy. (Photo courtesy of Continental Aviation and Engineering Corp.)

Whatever your problem may be, our engineering, development and production facilities are at your disposal. Write, wire or phone for information.

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pects of solid state masers, multilevel pumping schemes, traveling waves, and optical pumping (June 15-19).

Previously announced

New York University—Vacuum Metallurgy (June 1-2); Thermoelectric Materials (June 15-19); Ductile Iron (June 29-July 3); Titanium Metallurgy (Sept 14-15).

Pennsylvania State University—Machinability (June 7-12); Plastics (June 28-July 3).

Massachusetts Institute of Technology—Corrosion (June 22-26); Materials for Parachute and Retardation Devices (July 20-31).

University of Notre Dame—Sintering and Related Phenomena (June 15-17).

West Virginia University—Underground Corrosion (June 2-4).

Boston College—Industrial Spectrography (July 20-31).

University of Wisconsin—Plastics (May 26-27).

University of Michigan—Application of Stress Analysis to Design and Metallurgy (June 22-25); Modern Approach to Machining Problems (Aug 24-28).

Malleable Castings Set For New Research

A number of research projects aimed at producing better malleable irons and learning more about the properties and capabilities of the presently used grades are being sponsored by the Malleable Founders Society.

According to Hans Heine, technical director of the society, specific projects under way include: 1) studying the machinability of malleable irons, 2) determining and improving the high temperature properties of malleable irons, 3) investigating the effects of various elements in pearlitic malleable irons, and 4) learning more about the use of coining and hot pressing operations on malleable iron castings.

Announcement of these projects was made at the recent semi-annual meeting of the Malleable Founders

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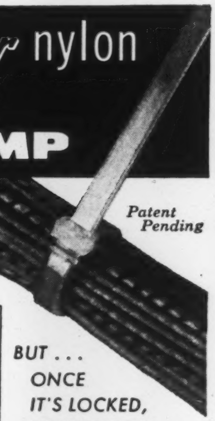
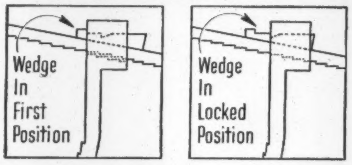
new! Weckesser nylon Wedge Lock BAND CLAMP



TWO-POSITION WEDGE PERMITS ADJUSTMENT FOR TEMPORARY ASSEMBLY . . .



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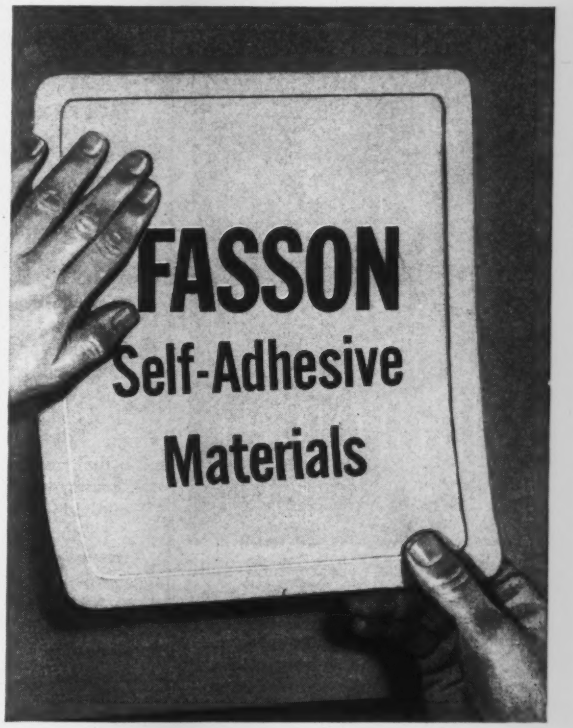

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No drilling, no fasteners, no tools or special skills required. Instant adhesion, no slipping, no cleaning up.

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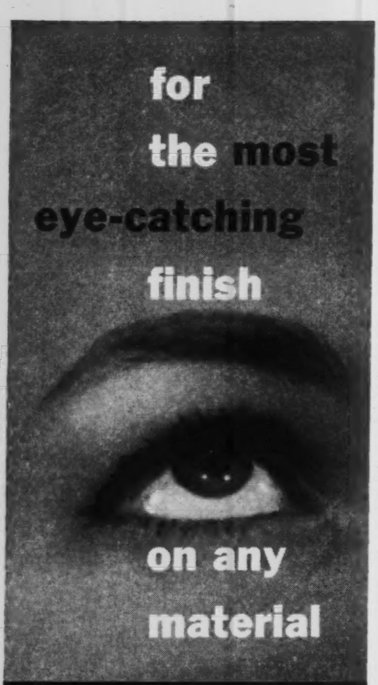

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Society. Also announced at the meeting was the following forecast for 1959: according to Richard W. Crannell, president, 18% more malleable castings will be used in 1959 than were used in 1958.

German, French Specs Now Being Translated

English translations of German and French industrial standards are now becoming available in this country through the American Standards Assn.

Thus far, a group of 175 newly translated German standards has arrived and an additional group of 57 standards is expected shortly. The standards are published by Deutscher Normenausschuss (DNA), the German national standards body. Subjects covered include: screws, washers, nuts, bolts, test methods for steel and various nonferrous metals, welding, plumbing fixtures and inch-millimeter conversion.

ASA has also received translations of 30 standards from the Association Francoise de Normalisation (AFNOR), the French national standards body. Subjects include: zinc alloy ingots, blast furnace cements and conveyor belting.

A complete list of the available standards, as well as individual standards, can be ordered from American Standards Assn., 70 E. 45th St., New York 17.

Engineers

Lawrence C. Rodgers, Jr., has been named product manager, special metals fabrication, Pfaudler Co., a division of Pfaudler Permutit Inc.

William T. Frost has been appointed staff engineer, Instrumentation Engineering Dept., Ampex Corp.

John Mutschler has been appointed factory superintendent, Touch-Plate Mfg. Corp., Paramount, Calif.

Robert F. Ochs, Westinghouse Electric Corp., has been appointed secretary, Rutgers Engineering Asso.

Seymour Levine has been named instrument project engineer, and **Carl C. D'Esposito** has been appointed to

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or, WHERE

...limited volume or high temperature of metal does not permit use of die casting
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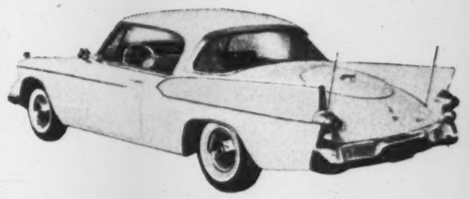

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Avery provides these finished products in a variety of different ways to meet your specifications exactly — any size, shape, color arrangement . . . all permanently beautiful!

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Avery Pressure-Sensitive Decorative Panel

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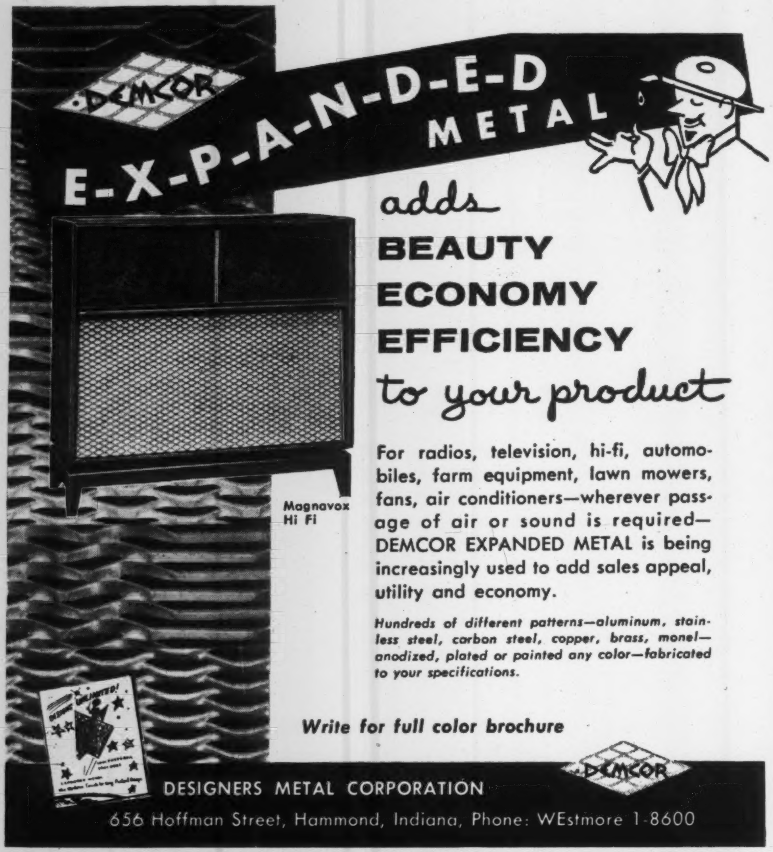

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News OF INDUSTRY

the engineering staff, Trio Laboratories, Inc.

Clyde Williams, former president of Battelle Memorial Institute, has been warded the James Douglas Gold Medal of the American Institute of Mining, Metallurgical and Petroleum Engineers, in recognition of "distinguished achievement in nonferrous metallurgy, including both beneficiation of ores and alloying and utilization of nonferrous metals."

Dr. Lloyd G. Mount is now head of the Chemical Research and Development Dept., Vitro Corp. of America.

Norman F. Spooner has been named manager of research and development, Hoskins Mfg. Co.

H. Maurice Banta has been appointed assistant director, research and technology, National Tube Div., U. S. Steel Corp.

F. A. Ritchings has been appointed consulting mechanical engineer, Ebasco Services Inc.

Walter E. Stewart has been named product engineering director, American Welding & Mfg. Co.

Dr. Clare P. Stanford has been appointed chief of the Engineering Dept., Nuclear Div., Martin Co.

Dr. Robert S. Ross, Goodyear Aircraft Corp., has been elected chairman, research and testing committee, Aircraft Industries Assn.

Asa Snyder has been appointed director of research and development, Clearing Div., U. S. Industries, Inc.

Herbert R. Herman is now chief chemist, Fiberfil, Inc.

Joseph Statsinger has been named director of engineering, Servo Corp. of America.

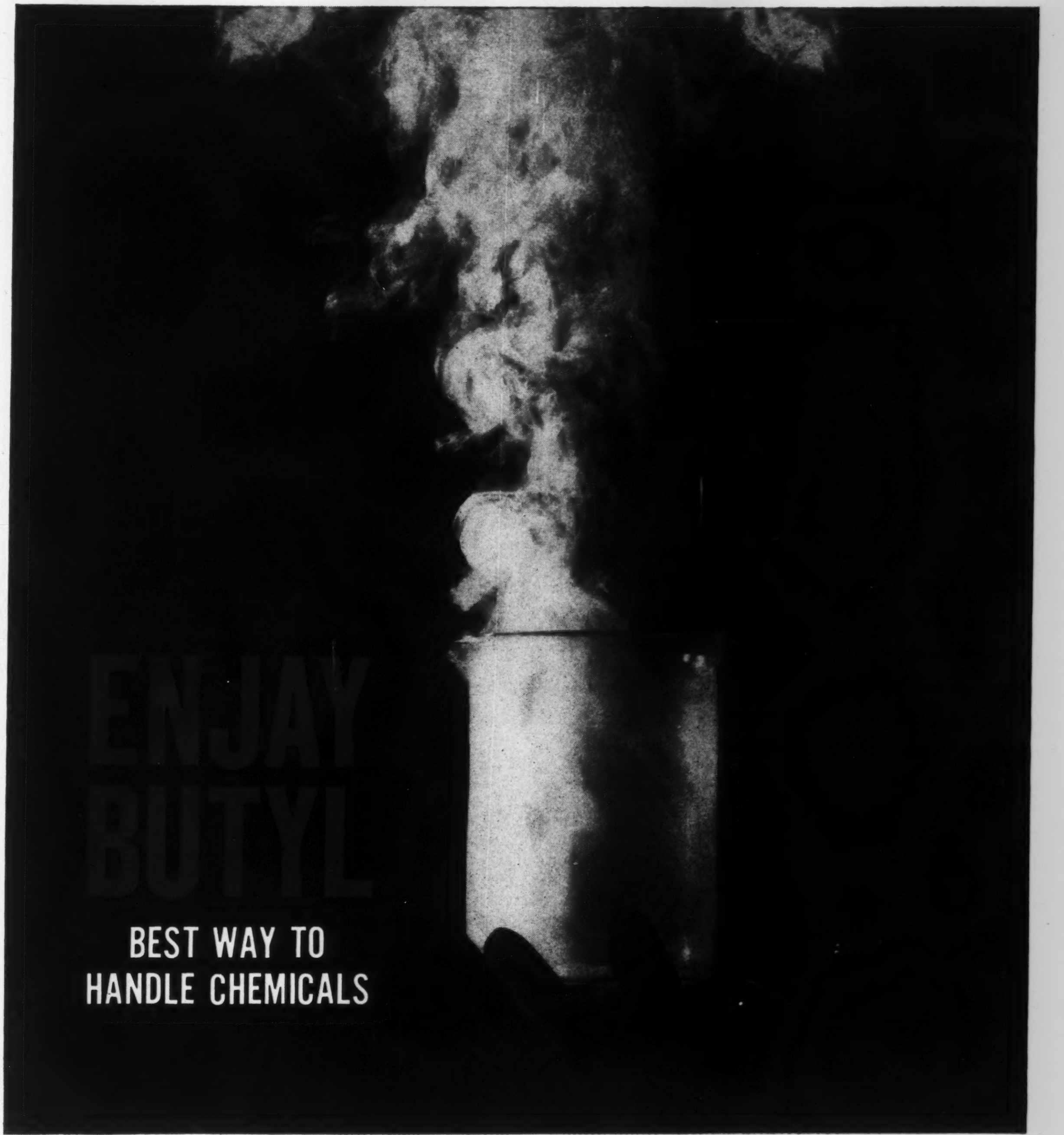
Dr. J. Earl Taylor has been appointed manager of research and development, Girdler Catalysts, Chemical Products Div., Chemetron Corp.

Dr. Robert D. Williams has been named manager of product development, Fibers Div., Celanese Corp. of America.

Saul Ricklin is now director of development, Dixon Corp.

Norman V. Petersen has been named chief, astronautics group, Norair Div., Northrop Corp.

Dr. Robert D. Stout, Lehigh University, has received the 1959 David Ford McFarland Award for achievement in metallurgy. The award is



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- Red fuming nitric acid
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- Ozone
- Hydrofluoric acid
- Ammonia
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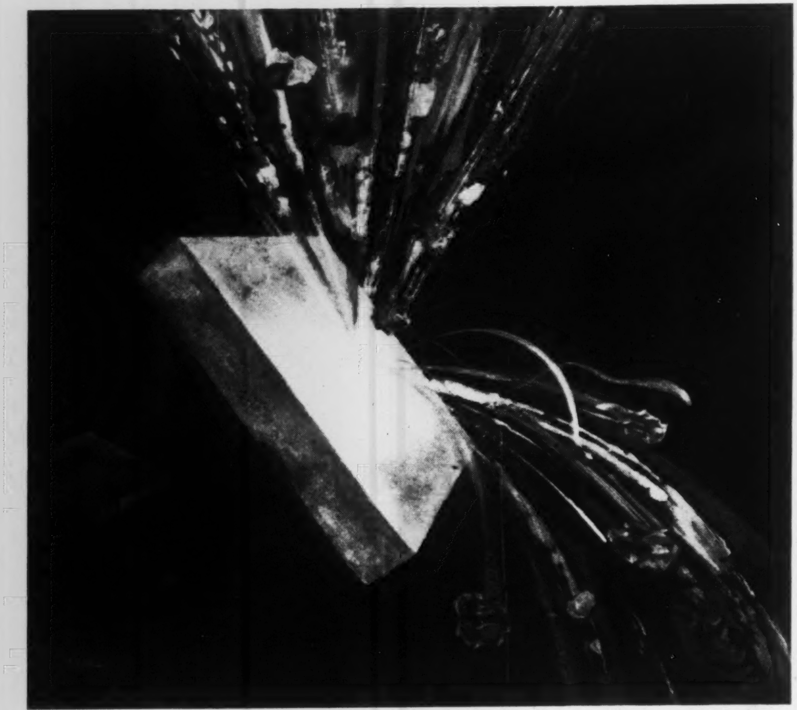
Rampart against Destruction

Closest approach to the indestructible material needed to combat extreme forces of corrosion, abrasion, heat and impact is a unique fused cast refractory . . . another development of advanced materials technology at Carborundum. For more information on this remarkable product, see below.



Fused-cast refractory resists extreme corrosion, wear, heat

Melted in electric furnaces and poured into moulds at 4500 F to form solid blocks and similar shapes, fused-cast refractories offer unique structures and properties not obtainable in any other refractory material. Dense, strong and impermeable, they top all man-made materials in resistance to wear. Inert to chemical action, they resist corrosion at virtually all temperatures. Ability to take considerable impact is a special feature.

HIGH TEMPERATURE APPLICATIONS already include glass melting tanks where temperatures range close to 3000 F, as well as hearth pavings and skid rails for metallurgical furnaces.

CORROSION RESISTANCE has been demonstrated in electrolytic cell liners for magnesium production, liners for synthesis gas generators and guides for pickling tanks.

RESISTANCE TO WEAR AND IMPACT has resulted in use in coke and sinter chutes and in ball mills for grinding abrasive materials.

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given by the Pennsylvania State University Chapter of the American Society for Metals.

Ramon J. Galvez, Jr., has been named supervisor of radiology, Cooper Alloy Corp.

Paul Mariotti is now applications engineer, Polytechnic Research & Development Co., Inc.

Kenneth R. Bragg has been appointed chief systems engineer, Parker Aircraft Co.

Dr. Robert M. Page, U. S. Naval Research Laboratory, has been given the Office of Naval Research's third annual Captain Robert Dexter Conrad Award for outstanding achievements in research and development.

Robert K. Baker, R. C. Mahon Co., has been elected chairman of the Industrial Heating Equipment Assn.'s newly created Oven Div.

Ralph A. Smith has been appointed chief materials and test engineer, Fulton Sylphon Div., Robertshaw-Fulton Controls Co.

Harrison F. Edwards has been named chief engineer, product engineering, Simmonds Aerocessories, Inc.

Alfred T. Glynn has been appointed chief engineer, Sturtevant Mill Co.

William R. Fraser has been named to the newly-established position of consulting engineer—product design, Technical Products Dept., General Electric Co.

Dr. R. W. Tess has been appointed research supervisor at Shell Development Co.'s Emeryville, Calif., Research Center.

Friedrich L. von Doblhoff is now director of engineering, International Div., Vertol Aircraft Corp.

Edwin J. Bernard has been named project engineer, Loftus Engineering Corp.

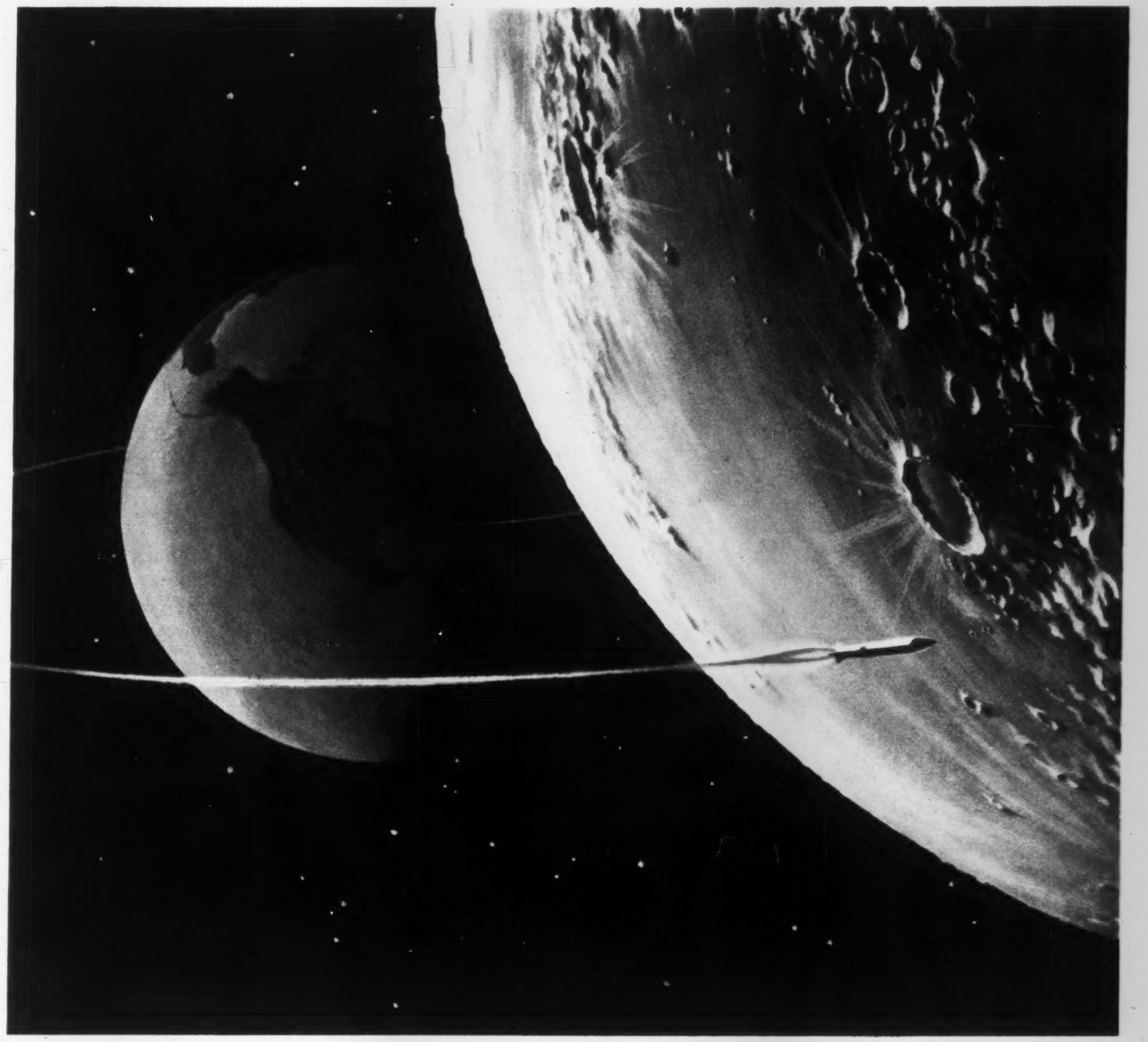
Dr. John M. Blocher, Jr. has been appointed chief of Battelle Memorial Institute's Inorganic Chemistry and Chemical Engineering Div.

George C. Mott has been named production control manager, Hamilton Standard Div., United Aircraft Corp.

Dr. Willard R. Sittner has been appointed manager, Semiconductor Div., Sperry Rand Corp.

Frank J. Scott has been named industrial engineer, Bunting Brass and Bronze Co.

John A. Lakits has been named operations engineer, Neville Concrete

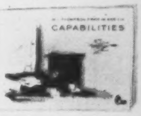


HITCO High Temperature Insulation Materials are helping U.S. to take a

GIANT STEP INTO SPACE

Rockets to the Moon will soon be routine – made possible by brilliant engineering achievements in all phases of Space Technology. One of the most vital of these is High Temperature Materials Research – HITCO's field of activity. *Astrolite*, a remarkable High Temperature Insulation Material by HITCO, resists up to 15,000° F. for short duration uses! Some of the possible applications for *Astrolite* are Missile Nose Cones, Rocket Engine Liners, Nozzles and Heat Shields. Take a Giant Step toward the solution of your High Temperature problem by calling in HITCO Engineers. No obligation, of course!

HITCO capabilities are described in this interesting new brochure. Please request on your business letterhead.



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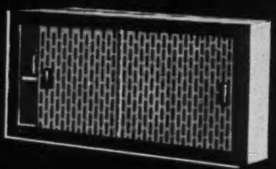

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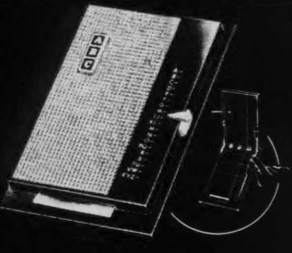

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News OF INDUSTRY

Pipe Co., a subsidiary of Pittsburgh Coke & Chemical Co.

Albert W. Kreutzberger has been appointed chief designer, Milwaukee Die Casting Co.

P. A. Haythorne has been named technical director, Superweld Corp.

Dr. George D. Sands has been appointed director of scientific requirements, Martin Co.

Charles M. Standart is now chief engineer, Becco Chemical Div., Food Machinery & Chemical Corp.

Max Schneiderman has been appointed manager of engineering, Oscilloscope Div., Electronic Tube Corp.

Wesley E. Niemond has been named head of the Tape Center Dept., Electronic Control Systems, Stromberg-Carlson.

Dr. David K. Eads has been named supervisor, chemical engineering process development section, Research Laboratories, Foster Grant Co., Inc.

Frank J. MacRae has been appointed manager, plastics technical service, Dow Chemical Co.

Companies

Wyle Laboratories and **Wyle Research Corp.** have announced a merger of the two companies, which will now operate under the name **Wyle Laboratories.**

Bettinger Corp. has moved to its new $1,500,000 plant in Milford, Mass.

Autonetics, a division of North American Aviation, Inc., has established a manufacturing engineering department, and E. H. Schaefer has been named chief of the new operation.

Adhesive Tape Corp. has acquired a new plant located at 58 Seabring St., Brooklyn 31, N. Y.

Federal Pacific Electric Co. has acquired **Economy Fuse and Mfg. Co.** of Chicago.

Monsanto Chemical Co. has begun construction of a new plant for the manufacture of Mersize in Nitro, W. Va.

American-Standard has formed an Industrial Div., created by the con-

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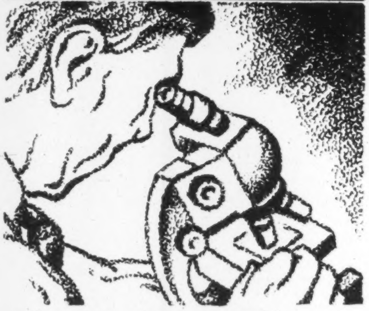

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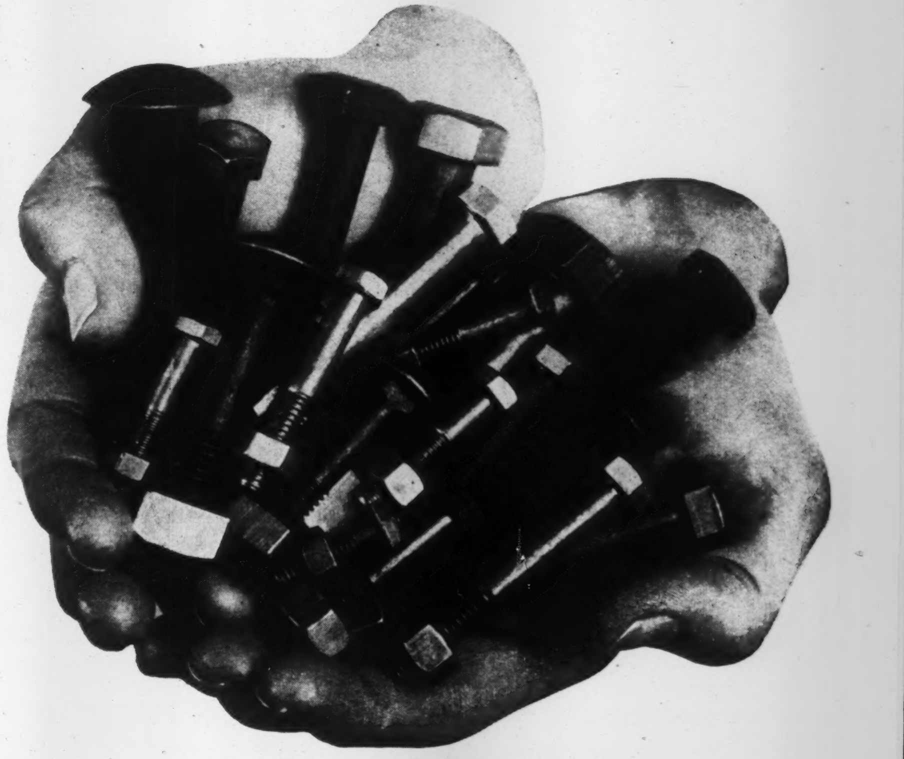

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solidation of its American Blower, Kewanee Boiler and Ross Heat Exchanger Divs.

Hostawax Co. is a new division of Progressive Color and Chemical Co., Inc.

Bethlehem Pacific Coast Steel Corp. has purchased the Vernon, Calif., plant of **U. S. Industries, Inc.**

Eugene Dietzgen Co. has purchased **Griscombe Products, Inc.,** which will be operated as a subsidiary of Dietzgen Co.

Weyerhaeuser Timber Co. has acquired **United Wood Corp.,** W. Memphis, Ark.

Jefferson Chemical Co., Inc. has begun production in its new ethylene plant at Port Neches, Tex.

Meridian Metalcraft, Inc., Whittier, Calif., has constructed a new aluminum dip brazing installation at 8739 S. Millergrove Dr., Whittier.

Combustion Engineering, Inc., has acquired **General Nuclear Engineering Corp.,** which will be operated as a subsidiary of Combustion Engineering.

Allis-Chalmers Mfg. Co.'s Steam Turbine Dept. has organized a new materials engineering section with Robert G. Matters as engineer-in-charge.

Hexcel Products Inc. has acquired certain assets of **Honeycomb Div., Young Spring & Wire Co.**

Therm, Inc., is the new name for **Therm-Electric Meters Co.**

Detrex Chemical Industries, Inc., plans a $¼-million expansion program at its Bowling Green, Ky. plant.

Scientific and Process Instruments Div., Beckman Instruments, Inc., has formed a new Custom Products Dept. with Stanford B. Spracklen as manager.

Riverside Plastics Corp. has purchased **Bischoff Chemical Corp.,** formerly owned by Miles Laboratories.

Ford Motor Co. plans a multi-million-dollar quality improvement and modernization program for its steelmaking facilities at its Rouge plant in Dearborn.

Lockheed Electronics and Avionics Div. is a newly-formed division of Lockheed Aircraft Corp.

Seiberling Rubber Co. has begun construction of a new plant at its

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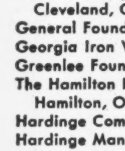
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Dayton Casting Co., Dayton, Ohio
Empire Pattern & Foundry Co., Tulsa, Okla. and Bonham, Texas
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundries, Inc., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Kennedy Van Saun Mfg. & Eng. Corp., Danville, Pa.
Lincoln Foundry Corp., Los Angeles, Calif.
Nordberg Manufacturing Co., Milwaukee, Wis. and St. Louis, Mo.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Foundries of FMC, Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario



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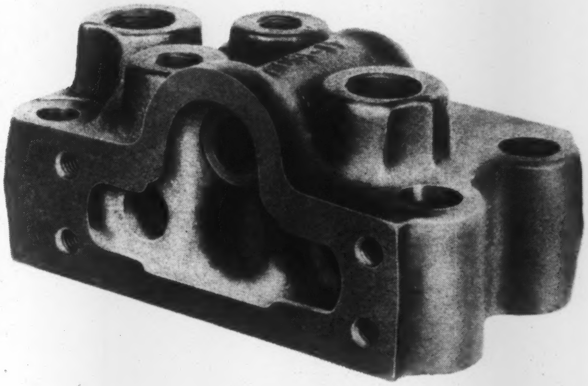

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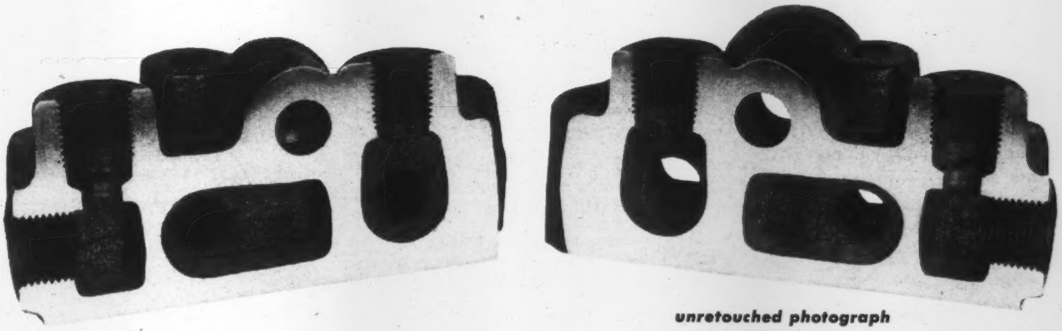

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News OF INDUSTRY

Plastics Div. facilities in Akron, Ohio.

Inertia Switch, Inc. has moved to new and larger quarters at 311 W. 43rd St., New York City.

Hooker Chemical Corp. has formed a **Western Chemical Div.**

Inland Steel Container Co., a division of Inland Steel Co., has installed a new facility in its Jersey City, N. J., plant for the production of steel shipping containers.

Metal & Thermit Corp. will expand its electrochemical research and development activities.

Foster D. Snell, Inc.'s Elastomer Section has established a new consulting service which will provide subscribers in the rubber industry with a series of 12 monthly reports.

Royal Industries, Inc. has dedicated a $100,000 engineering research and development center at 1031 Westminster, Alhambra, Calif.

Ardmore Products, Inc. has moved to larger quarters at Aldene Rd. and First Ave., Roselle, N. J.

U B S Chemical Corp. has broken ground for a pilot plant and laboratory in Marlboro, Mass.

Westinghouse Electric Corp. plans a $3 million expansion program at its high power laboratory in East Pittsburgh, Pa.

Nalge Co., Inc., and **American Vulcathene,** a division of Nalge, have moved to new quarters at 75 Panorama Creek Dr., Rochester, N. Y.

Engineered Materials is a new company specializing in industrial raw materials and chemicals; it is located at 509 Fifth Ave., New York 17.

Nortronics Div., Northrop Corp., plans to build a $4 million engineering, research and development, and pilot production facility.

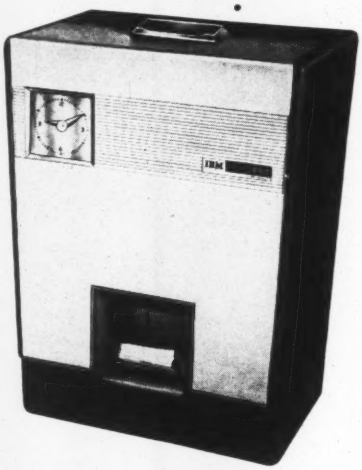
Tamar Electronics, Inc., has acquired a 10,000-sq-ft facility for expanded microwave-electronics research.

Spencer Chemical Co. plans to construct a uranium dioxide processing plant at its Jayhawk Works, Pittsburg, Kan.

Denver Laboratories is the new name of **Electronic Instrumentation Co.,** Ramo-Wooldridge Div., Thompson Ramo Wooldridge, Inc.

Hercules Powder Co. and **Stauffer Chemical Co.** have reached an agreement under which the two firms will jointly form a new company to manu-

Another product made better with MOLDED FIBER GLASS



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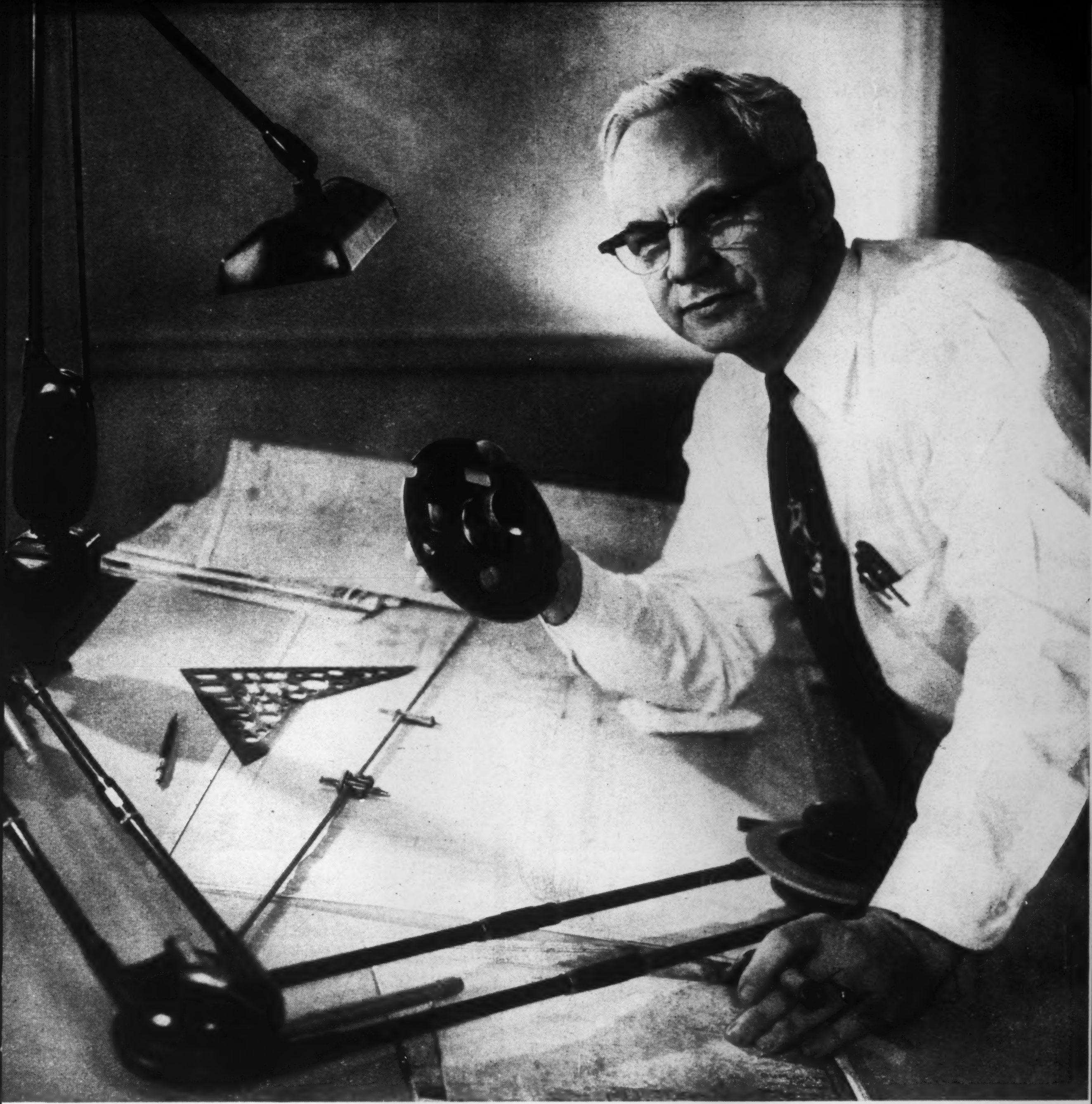

"When you design for quality the steel is important" —ALBERT R. COLEMAN—DIRECTOR OF ENGINEERING

"Steel quality is all important to the designer," says Albert Coleman, Director of Engineering at Whirlpool's Clyde, Ohio plant, "and we've found we can trust Sharon to deliver what they promise."

Sharon engineers know the importance of working in close coordination with engineers like Mr. Coleman to thoroughly understand the application and then make certain the steel supplied will do the job for which it was intended.

Better appliances depend on steel. Leading appliance makers, like Whirlpool, have learned they can depend on quality steels—consistently—from the mills of the *Sharon Steel Corporation, Sharon, Pa.*

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Convair Instruments, Convair Div. of General Dynamics Corp., has moved to new and larger quarters at 3595 Frontier St., San Diego, Calif.

Societies

Welded Honeycomb Mfrs. Assn. announces the following 1959 officers: president—Walter R. Hagen, John J. Foster Mfg. Co.; vice president—John Stansbury, Swedlow Plastics Co.; secretary—R. B. Runkle, Hexcel Products Inc., and treasurer—William Kirk, Specialty Mfg. Co.

Aircraft Castings Assn. is a newly-formed, non-profit corporation for the promotion of "increased use of ferrous castings for the aircraft, missile and related industries." With headquarters in Los Angeles, the organization lists the following present members: Electric Steel Foundry Co.; General Metals Corp.; Hanford Foundry Co.; Lebanon Steel Foundry; Pacific Alloy Engineering Corp.; Stanley Foundries, Inc.; and Symington-Gould Div., Symington Wayne Corp.

Industrial Heating Equipment Assn., Inc. has elected the following 1959 officers: president—R. L. Harper, Harper Electric Furnace Corp.; vice president—W. E. Benninghoff, Ohio Crankshaft Co.; treasurer—Roy R. Snyder, W. S. Rockwell Co.; executive vice president—Robert E. Fleming; and executive committee member—R. B. Hanna, General Electric Co. New directors are: W. E. Benninghoff, Ohio Crankshaft Co.; R. M. Buck, Bryant Industrial Products Corp.; and Hugh J. Pugsley, Swindell-Dressler Corp.

Aircraft Industries Assn., Materials Procurement Committee, has named the following new officers: chairman—W. L. Hoffman, Chance Vought Aircraft, Inc.; and vice chairman—E. D. Carter, Martin Co.

Permanent Magnet Producers Assn., a newly formed organization located at 27 E. Monroe St., Chicago 3, has elected the following officers: president—R. J. Studders, General Electric Co.; vice president—William G. Scharnberger, Crucible Steel Co. of America; treasurer—W. E. Gilman, General Magnetics Corp.; and executive secretary—Harry Dolan.

(News of Meetings on p 252)

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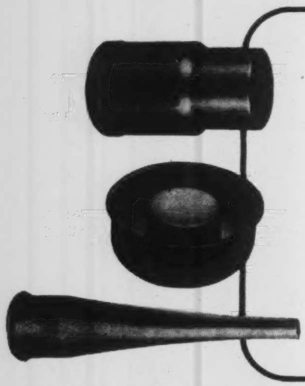

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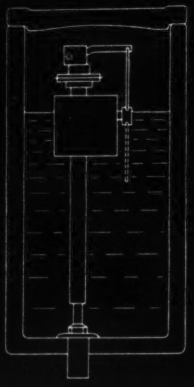

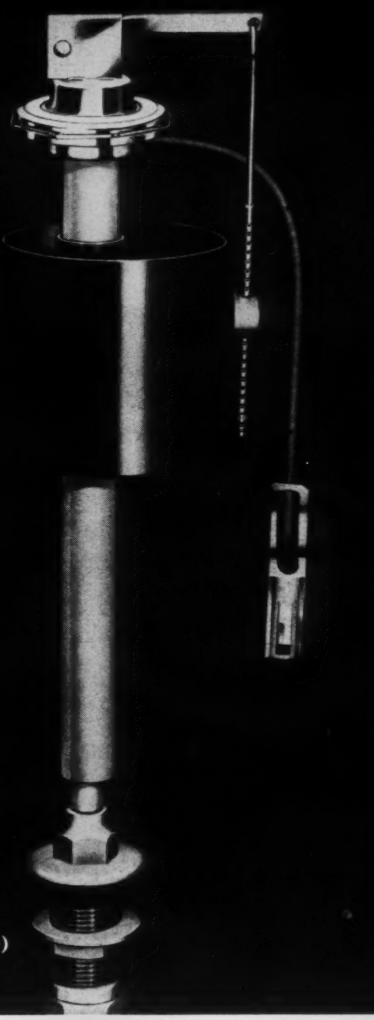

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TYPICAL PHYSICAL AND CHEMICAL PROPERTIES OF FORTIFLEX

Properties of Fortiflex "A" Related to Melt Index

PHYSICAL PROPERTIES	ASTM METHOD	UNITS	FORTIFLEX RESINS			
			A-20	A-70	A-250	A-500
Melt Index	D-1238-52T	—	0.2	0.7	2.5	5.0
Heat Distortion Temp. (66 psi)	D-648-45T	°F.	185	185	180	180
Brittleness Temp.	D-764-52T	°F.	—200	—180	—160	—100
Impact Strength, izod (⅛" x ½" injection-molded bars)	D-256-54T	ft. lb./in. notch	23	18	13	3
Tensile Strength, Max., 0.2 in./min.	D-638-52T	psi.	3700	3600	3500	3300
Elongation, First Tensile Yield Point	D-638-52T	%	25	25	25	25

Properties of Fortiflex "A" Not Affected by Melt Index

PHYSICAL PROPERTIES	ASTM METHOD	UNITS	VALUE
Density		g/cc.	0.96
Refractive Index	D-542-50	n_D^{25}	1.54
Hardness, Shore D	D-676-49T		65
Stiffness	D-747-50	psi.	150,000
Water Absorption (⅛" specimen, 24 hr. immersion @ room temp.)	D-570-54T	%, wgt. gain	<0.01
Flammability	D-635-44	in./min.	1.0
*Mold Shrinkage, length		in./in.	0.03 to 0.05
width		in./in.	0.02 to 0.04

*Measured on injection molded tensile bar. Mold shrinkage depends on part design and molding conditions.

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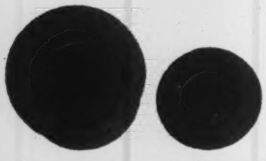
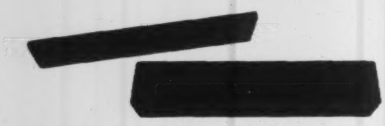


- **Molds for powder metallurgy?**



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News OF INDUSTRY

Meetings

ELECTROCHEMICAL SOCIETY, spring meeting. Philadelphia. May 3-7.

INSTITUTE OF RADIO ENGINEERS, 7th regional conference and electronics exhibit. Albuquerque, N. M. May 3-8.

SOCIETY OF AIRCRAFT MATERIALS AND PROCESS ENGINEERS, Eastern Div., spring meeting. New York City. May 15.

AMERICAN SOCIETY FOR METALS, 1959 Tri-State meeting on "Modern Methods of Problem Solving in Metallurgy." Poughkeepsie, N. Y. May 15.

NATIONAL INDUSTRIAL SERVICE ASSN., 1st international convention. Montreal. May 17-20.

AMERICAN CERAMIC SOCIETY, annual meeting. Chicago. May 17-21.

AMERICAN INSTITUTE OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS, New England regional conference. Hartford, Conn. May 21-22.

MALLEABLE FOUNDERS' SOCIETY, annual meeting. Hot Springs, Va. May 25-26.

AMERICAN SOCIETY FOR QUALITY CONTROL, annual convention and all-industry production and quality control exposition. Cleveland. May 25-27.

4th annual Design Engineering Conference, American Society of Mechanical Engineers. Convention Hall, Philadelphia. May 25-28.

4th annual Design Engineering Show. Convention Hall, Philadelphia. May 25-28.

AMERICAN IRON AND STEEL INSTITUTE, annual meeting. New York City. May 27-28.

COLUMBIA UNIVERSITY, Dept. of Industrial Engineering, annual industrial research conference. New York City. May 31-June 5.

AMERICAN ELECTROPLATERS' SOCIETY, golden jubilee convention and international exposition. Detroit. June 15-19.

AMERICAN SOCIETY FOR TESTING MATERIALS, 62nd annual meeting. Atlantic City, N. J. June 21-26.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer general meeting. Seattle. June 22-26.

INSTITUTE OF RADIO ENGINEERS AND WESTERN ELECTRONIC MFRS. ASSN., 1959 Western electronic show and convention. San Francisco. Aug 18-21.

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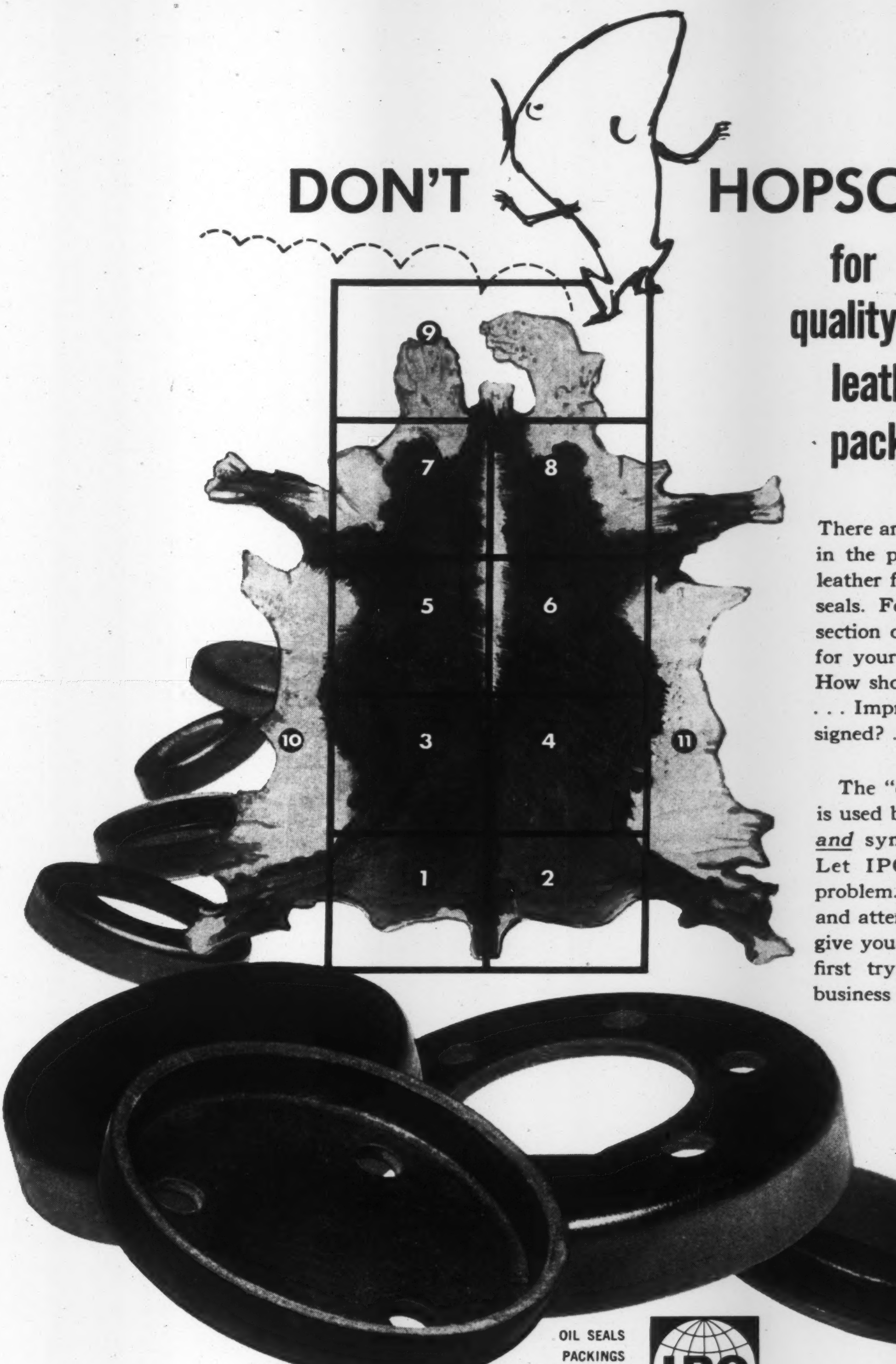

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TECHNICAL LITERATURE

Books

Semiconductors. *Edited by N. B. Hannay. American Chemical Society Monograph No. 140. Reinhold Publishing Corp., New York. 1959. Cloth, 6 by 9 in., 767 pp. Price $15*

This book presents the fundamental science of semiconductors from a chemical point of view. Semiconducting materials are treated individually, the amount of attention given each material being in direct relation to the degree of understanding of that material which exists.

The various chapters, written by leaders in semiconductor research, give information on: Group IV semiconductors; properties of some covalent semiconductors; effect of imperfections on germanium and silicon; organic semiconductors; chemistry of some compound semiconductors; and semiconductor crystal growing.

A Dictionary of Metallurgy. *A. D. Merriman. Pitman Publishing Corp., New York. 1959. Cloth, 9 by 11 in., 400 pp. Price $25*

Definitions for approximately 7000 words and phrases used in metallurgy. The book contains 283 illustrations and 236 tables.

Technical Societies Guide: 2nd Edition. *Industrial Publicity Assn., New York. 1958. Paper, 8½ by 11 in., 32 pp. Price $3*

Procedures for presenting technical papers to societies and trade associations.

ASTM Standards on Plastics: 1958. *American Society for Testing Materials, Philadelphia. 1958. Paper, 6 by 9 in., 1100 pp. Price $8*

This edition contains 43 standards not appearing in the previous 1957 edition. Significant new standards include specifications for nonrigid vinyl chloride plastics sheeting, glass fabric-reinforced epoxy resin laminates and polymethylstyrene molding and extrusion material.

The book also contains new standards on plastics pipe, giving dimensions for SWP and IPS sizes of cellulose acetate butyrate and acrylonitrile-butadiene-styrene pipe.

Theory of Beams. *T. Iwinski. Pergamon Press Inc., New York. 1958. Cloth, 5½ by 8½ in., 85 pp. Price $3.50*

This monograph, translated from the Polish by E. P. Bernat, is the first part of a major project on the application of the Laplace transformation method to static problems in theory of structures. The Laplace method of solving linear differential equations is a form of shorthand which can be used to obtain very quick solutions to many engineering problems.

International Register of Wire, Rod and Strip: 1957-1958. *Lindsay's Wire Publications, Wolverhampton, Staffs, England. 1958. Cloth, 6 by 9½ in., 248 pp. Price $3.50*

Welding Handbook: 4th Edition—Section 2. *Edited by Arthur L. Phillips. American Welding Society, New York. 1958. Cloth, 6 by 9 in., 550 pp. Price $9*

Containing 845 illustrations and nearly 100 tables, this book gives comprehensive and

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a typical example

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This is but one of many solutions to fabrication problems offered by sprayed metals to design engineers. In addition to the aluminum example given, zinc is also commonly used for corrosion-proofing in many production applications, such as steel capacitor cases, refrigerator parts, pole line hardware, etc. Sprayed zinc is also used to replace coatings burned, threaded, or machined off during fabrication.

For a round-up of some typical applications and engineering data on the characteristics of metallized coatings, write for Bulletin No. 136-A.

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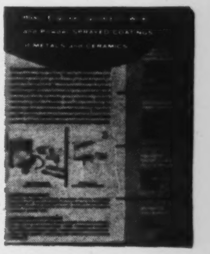

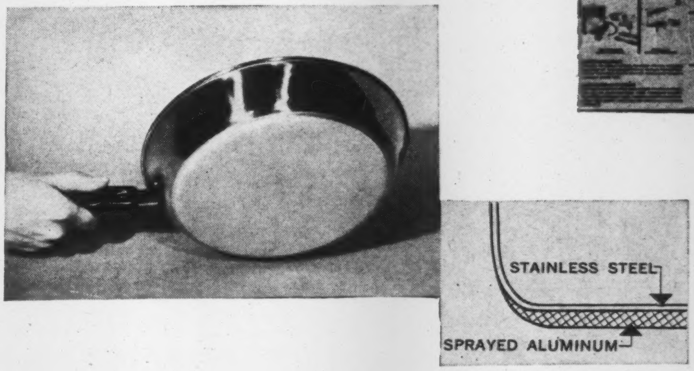

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TECHNICAL LITERATURE

up-to-date information on gas, arc and resistance welding procedures. A chapter is devoted to each process, or group of processes, and each group is followed by a chapter describing equipment. An entire chapter is devoted to welding symbols.

Semiconductor Abstracts: Vol. 4—1956 Issue. *John Wiley & Sons, Inc., New York. 1959. 8½ by 11 in., 456 pp. Price $12*
Included in this book are abstracts of papers published in various magazines, as well as abstracts of papers given at meetings of the American Physical Society and the Electrochemical Society. Semiconductor materials discussed include germanium, silicon, carbon, cadmium sulfide, barium oxide, selenium and carbon.

Elements of Physical Metallurgy: 2nd Edition. *A. G. Guy. Addison-Wesley Publishing Co., Inc., Reading, Mass. 1959. Cloth, 6 by 9 in., 542 pp. Price $9.50*
This revised textbook is designed for introductory courses in physical metallurgy. Principal features of the revision are: 1) introduction of dislocation theory; 2) addition of material on electron theory of metals; and 3) introduction of a chapter on phases in metal systems.

Reports

Protecting high strength steel PROTECTIVE COATINGS ON HIGH TEMPERATURE STRENGTH ALLOYS. *Translated from the Russian "Metallovendeniye i Obrabotka Metallov," 1958, No. 6. Available from Henry Brutcher, P. O. Box 157, Altadena, Calif. Price $4.85 (HB-4251)*
Discusses the use of chromium electroplates and enamel coatings to prevent localized corrosion of high temperature strength nickel-base alloys that come in contact with vanadium and sodium-containing fuels in gas turbines.

Heat vs magnetic properties THE EFFECT OF TEMPERATURE OF THE MAGNETIC PROPERTIES OF NICKEL-IRON ALLOYS. *J. J. Clark and J. F. Fritz, Westinghouse Electric Corp. Dec '57. 36 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1 (PB 131799)*
Information on the effects of temperature variation on the d.c. magnetic properties of six nickel-iron alloys. Normal magnetizing curves for various temperatures between –75 and 500 F are presented, with curves illustrating the behavior of saturation induction, remanence and coercivity over this temperature range.

Bending aluminum BENDING ALUMINUM. *1958. 47 pp. Aluminium Development Assn., 33 Grosvenor St., London, W. 1, England. Price 28¢ (No. 24)*
Bending properties of heat treatable and non-heat-treatable aluminum alloys, and aluminum sheet, strip, plate, bar, sections and tubes.

Refractories for rockets ROCKET REFRACTORIES. *H. B. Porter, Naval Ordnance Test Station. Aug '55. 55 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.50 (PB 131503)*
This report sets forth required characteristics of acceptable rocket refractories. Basic refractory substances, including metal oxides, metal-metalloid compounds and intermetallic compounds, are discussed—both in-

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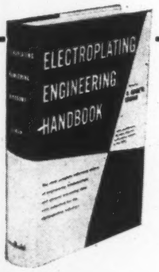

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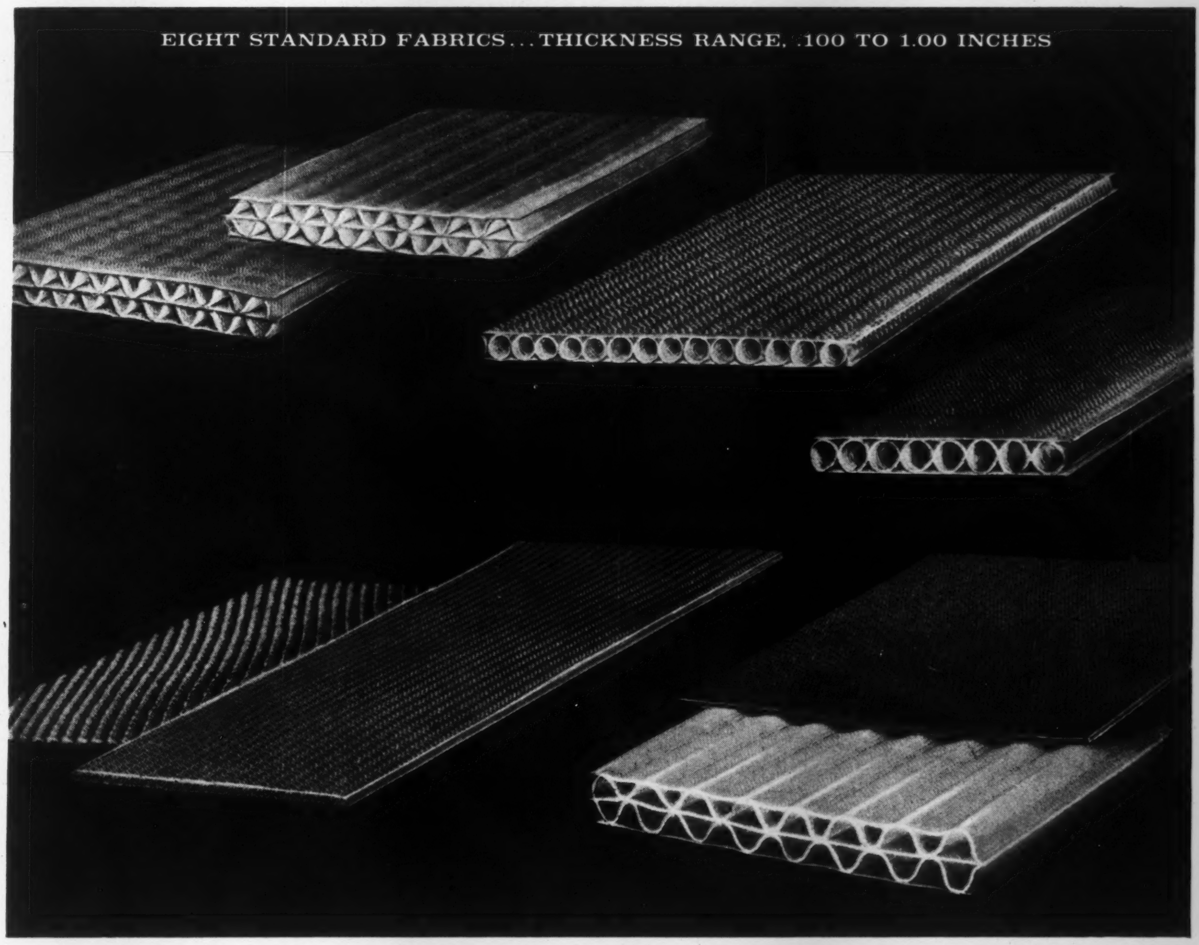

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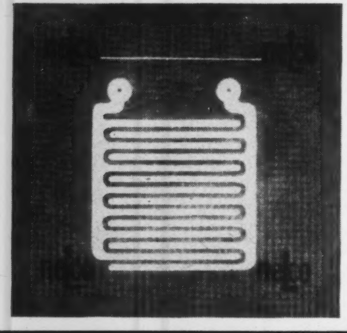

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dividually and as ingredients of bonded ceramic and cermet compositions.

Stainless steel products BUYERS' GUIDE FOR STAINLESS STEEL PRODUCTS AND SERVICES. *1958. 159 pp. Committee of Stainless Steel Producers, American Iron and Steel Institute, 150 E. 42nd St., New York 17.*

This reference manual lists approximately 3000 firms which make stainless steel products or offer services pertaining to stainless steel. The manual contains 188 specific and general stainless steel product categories.

Rare earth metals SELECTION AND EVALUATION OF RARE AND UNUSUAL METALS FOR APPLICATION TO ADVANCED WEAPONS SYSTEMS. *B. Love, Research Chemicals, Inc. June '58. 185 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $3 (PB 151311)*

Literature survey dealing with the rare earth metals hafnium, rhodium and ruthenium. Discusses the abundance and distribution of the rare earth elements, and gives mechanical properties of rare earths and their compounds. The report contains approximately 100 tables and illustrations.

Welding 347 stainless WELDING TYPE 347 STAINLESS STEEL PIPING AND TUBING. *George E. Linnert. 1958. 103 pp. Welding Research Council, 29 W. 39th St., New York 18. Price $3.50 (No. 43)*

Facts are supplied on microstructure and properties of type 347 stainless steel wrought material, castings and weld metal which later help explain the properties of welded joints. The main portion of the report is devoted to welding procedures and joint properties. Causes and cures of welding defects are thoroughly covered.

Titanium-cerium alloys THE ELEVATED TEMPERATURE CHARACTERISTICS OF INTERNALLY OXIDIZED TITANIUM-CERIUM ALLOYS. *R. H. Hiltz, Jr., Watertown Arsenal. 15 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price 50¢ (PB 131788)*

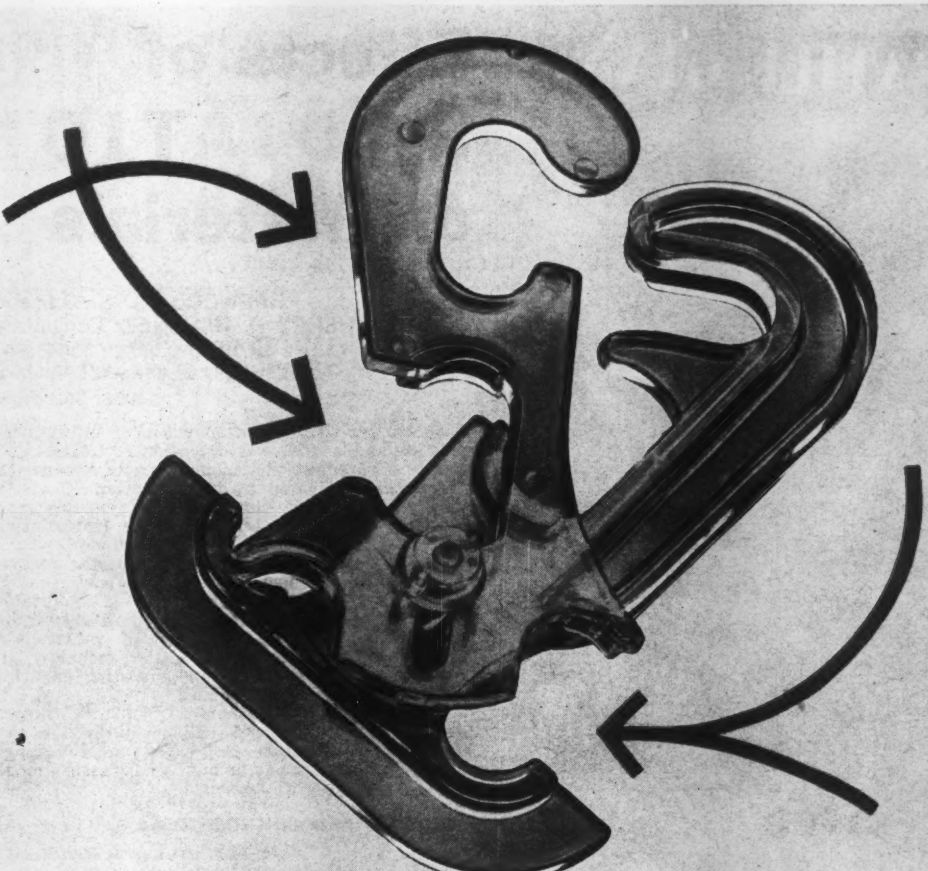
Results of this study of the internal oxidation of cerium in titanium indicated that significant benefits in the strength of titanium can be achieved for service above 930 F.

Germanium-silicon alloys INVESTIGATION OF GERMANIUM-SILICON ALLOYS: FINAL REPORT. *C. C. Wang, Sylvania Electric Products, Inc. Feb '55. 48 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1.25 (PB 131422)*

Semiconductor devices made of germanium-silicon alloys were shown to operate at temperatures higher than those of germanium. Alloy lifetimes were low as compared with germanium. The germanium-silicon alloys were prepared by an isothermal solidification technique.

Fatigue of aluminum AN INVESTIGATION OF THE EFFECTS OF ATMOSPHERIC CORROSION ON THE FATIGUE LIFE OF ALUMINUM ALLOYS. *Herbert A. Leybold, Herbert F. Hardrath and Robert L. Moore, Langley Aeronautical Laboratory. Sept '58. 17 pp. Available from National Advisory Committee for Aeronautics, 1512 H St., Washington 25, D. C. (TN 4331)*

Atmospheric effects shortened the average fatigue lives of 7075-T6 and 2024-T3 aluminum specimens in the unclad condition by a factor of about three. Atmospheric effects shortened the fatigue life of 7075-T6 in the clad condition by a factor of about 1.5, and had no significant effect on the average fatigue life of 2024-T3 clad specimens.



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Effects of RADIATION on Materials

Edited by **J. J. HARWOOD,** U. S. Office of Naval Research; **HENRY H. HAUSNER,** Consultant to The Martin Co.; **J. G. MORSE,** Nuclear Div., The Martin Co.; and **W. G. RAUCH,** U.S. Office of Naval Research

1958, 362 pages, $10.50

The changes that radiation produces in metals, ceramics, plastics and a wide variety of other materials are thoroughly covered in this momentous new book. It contains the papers delivered at the radiation effects colloquium jointly sponsored by the Office of Naval Research and The Martin Company at Johns Hopkins University in March 1957.

Twelve leading authorities analyze the results of their own actual experiments with various materials. Solid state physicists classify fundamental and qualitative effects according to type. Metallurgists and chemical engineers make a quantitative evaluation of radiation effects on physical properties. The book also includes current concepts of radiation effects and discusses experimental approaches to radiation studies.

The outstanding authorship, and the subject's timeliness and importance establish this book as a milestone in technical literature. An extensive bibliography brings together the enormous amount of literature on the subject from every part of the world.

CONTENTS AND CONTRIBUTORS:

Defects in Solids and Current Concepts of Radiation Effects—G. J. DIENES, Brookhaven National Laboratory.

Experimental Approaches to Radiation Studies—Radiation Sources and Desimetry—J. C. WILSON, Oak Ridge National Laboratory.

Radiation Effects on Physical and Metallurgical Properties of Metals and Alloys—E. S. BILLINGTON, Oak Ridge National Laboratory.

Influence of Radiation Upon Corrosion Behavior and Surface Properties of Metals and Alloys—M. SIMNAD, General Atomics.

Effects of Radiation on Electronic and Optical Properties of Inorganic Dielectric Materials—R. SMOLOCHOWSKI, Carnegie Institute of Technology.

Effects of Radiation on Semiconductors—H. Y. FAN and K. LARK-HOROVITZ, Purdue University.

Cores, Liquid Coolants and Control Rods—C. E. WEBER, General Electric Co. (Knolls Atomic Power Laboratory).

Moderators, Shielding and Auxiliary Equipment—G. R. HENNIG, Argonne National Laboratory.

Experimental Techniques and Current Concepts—Organic Substances—M. BURTON, University of Notre Dame.

Effects of Radiation on Behavior and Properties of Polymers—A. CHARLESBY, Tube Investments Ltd., Cambridge, England.

Kinetics of the Gamma-Induced Graft Copolymerization of Vinyl Acetate to Teflon—A. J. RESTAINO, Nuclear Div., The Martin Co.

Bibliography—H. FRIEDEMANN

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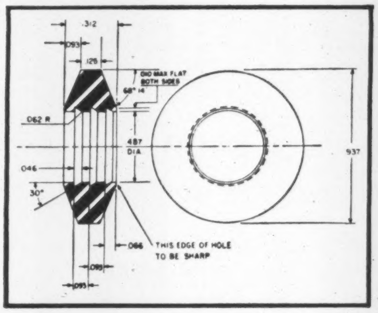

High-precision is indicated in the close tolerances of this quadruple-landed seal for auto shock absorbers—more economically produced in volume through Ohio Rubber's new high-speed, continuous molding process.

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9DE1

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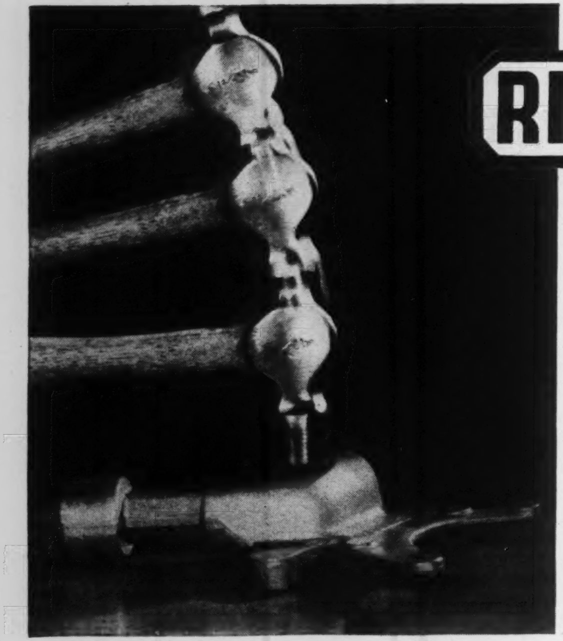

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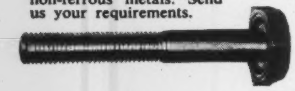

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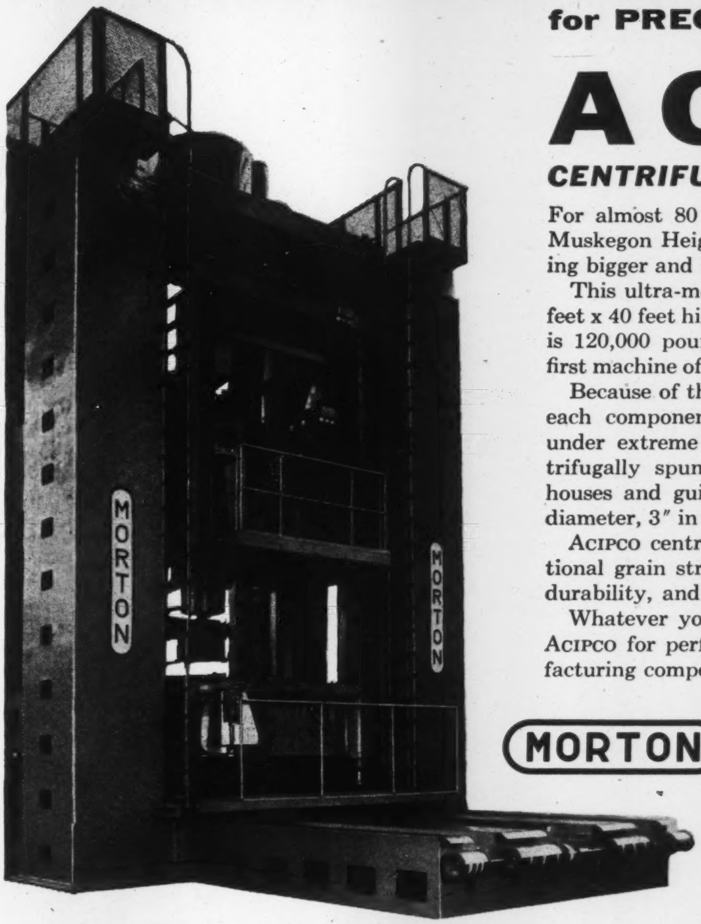

For almost 80 years, Morton Manufacturing Company of Muskegon Heights, Michigan, has been progressively building bigger and better machine tools.

This ultra-modern turning and boring mill is 27 feet x 22 feet x 40 feet high, and weighs 525,000 pounds. Load capacity is 120,000 pounds. Driven with 210 horse-power, it is the first machine of its type wherein the work remains stationary.

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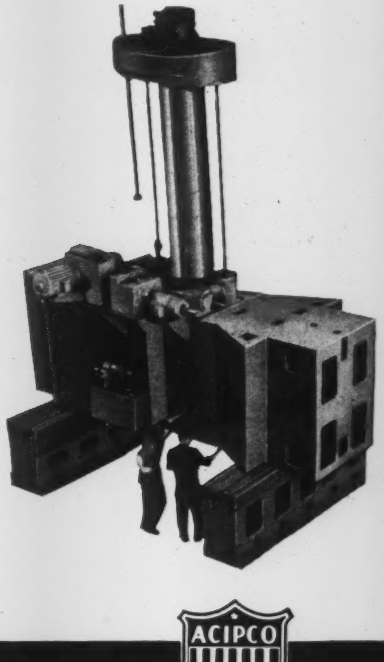

Morton Manufacturing Company, of Muskegon Heights, Michigan, is a leading manufacturer of heavy duty machinery for the machine tool industry. Boring mills; drillers, planers, as well as special machine tools for national defense and the development of new processes are among their products.

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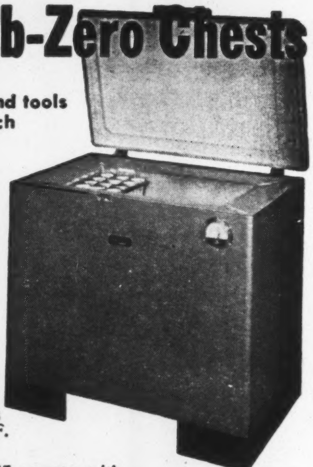

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			Rm. 70°	Rm. 110°	L	W	H	L	W	H
Sub-Zero	SZH153	1.5	−95° F.	−85° F.	42″	28″	42¾″	23″	9″	12½″
Sub-Zero	SZH653	6.5	−85° F.	−75° F.	60″	28″	42¾″	47″	15″	16″
Sub-Zero	SZHC657	6.5	−140° F.	−125° F.	60″	28″	42¾″	47″	15″	16″
Rivet Cooler	RSZ503	5.0	−30° F.	−20° F.	42″	28″	41″	30″	16″	18″

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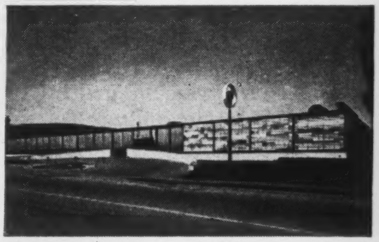

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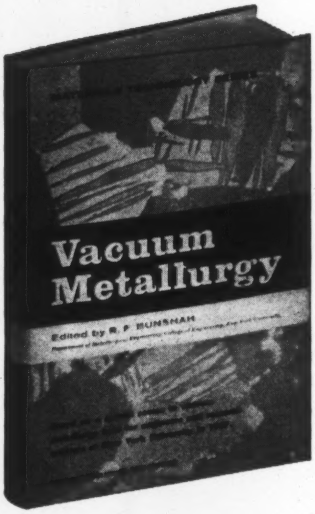

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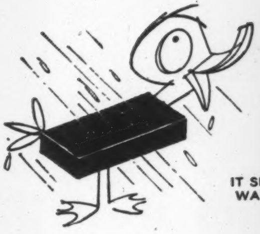

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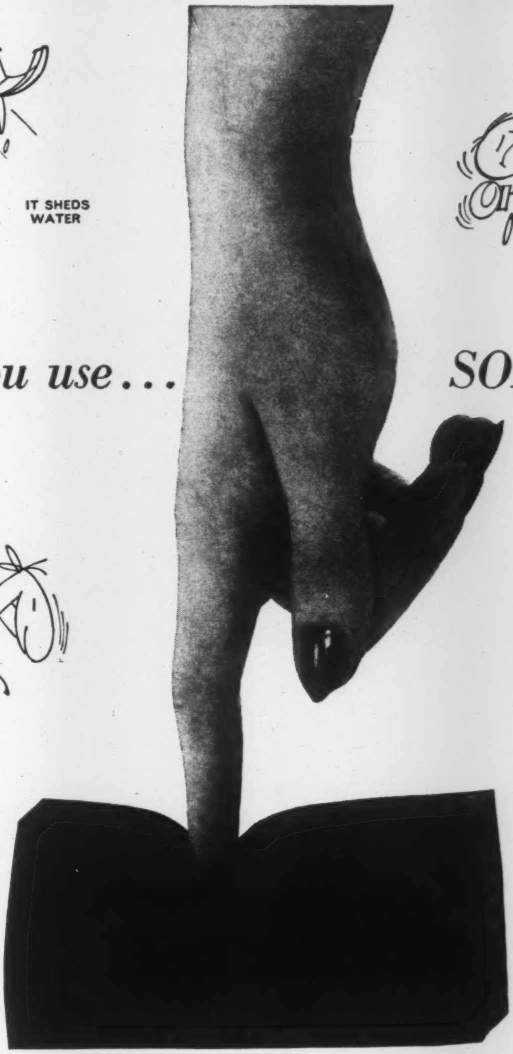

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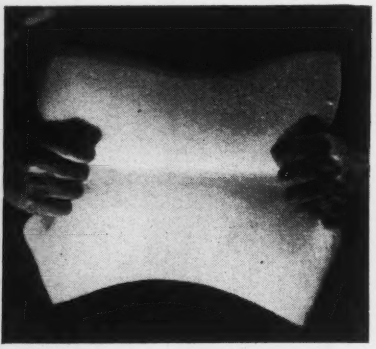

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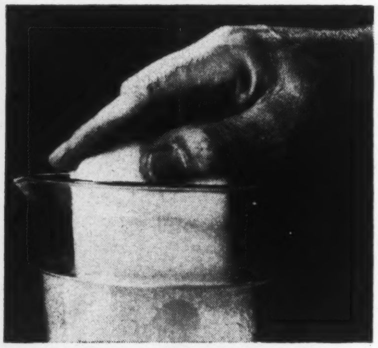

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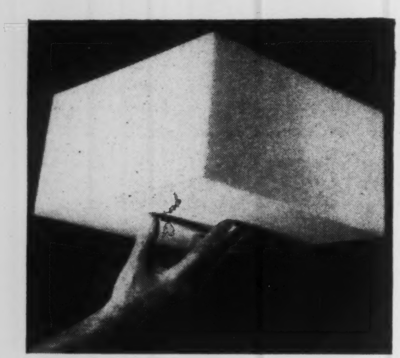

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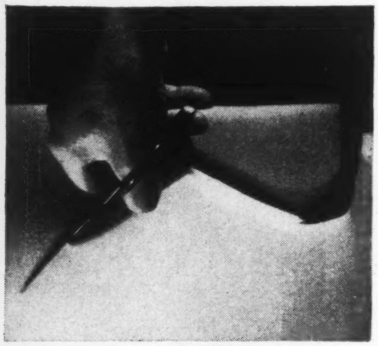

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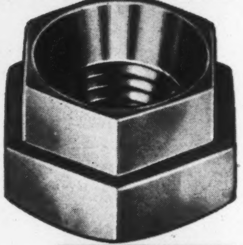

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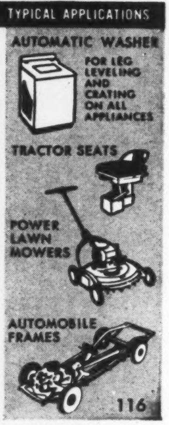

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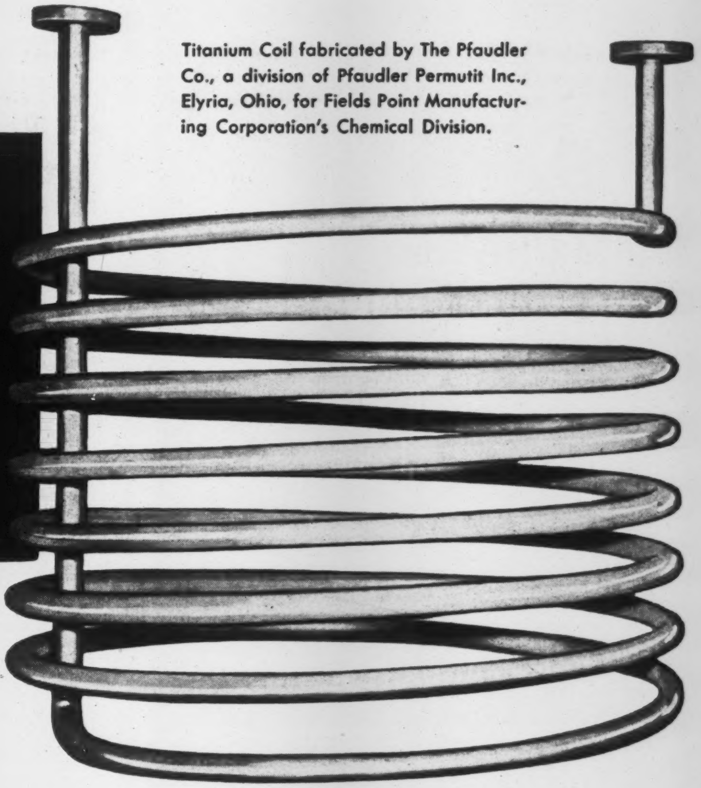

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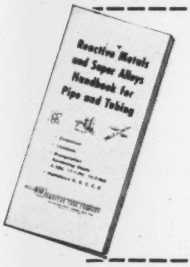

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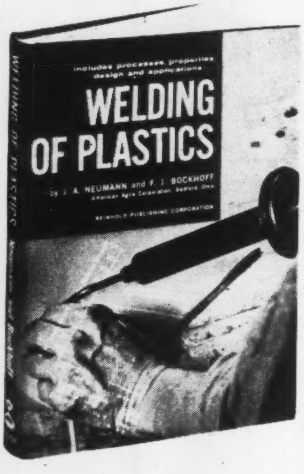
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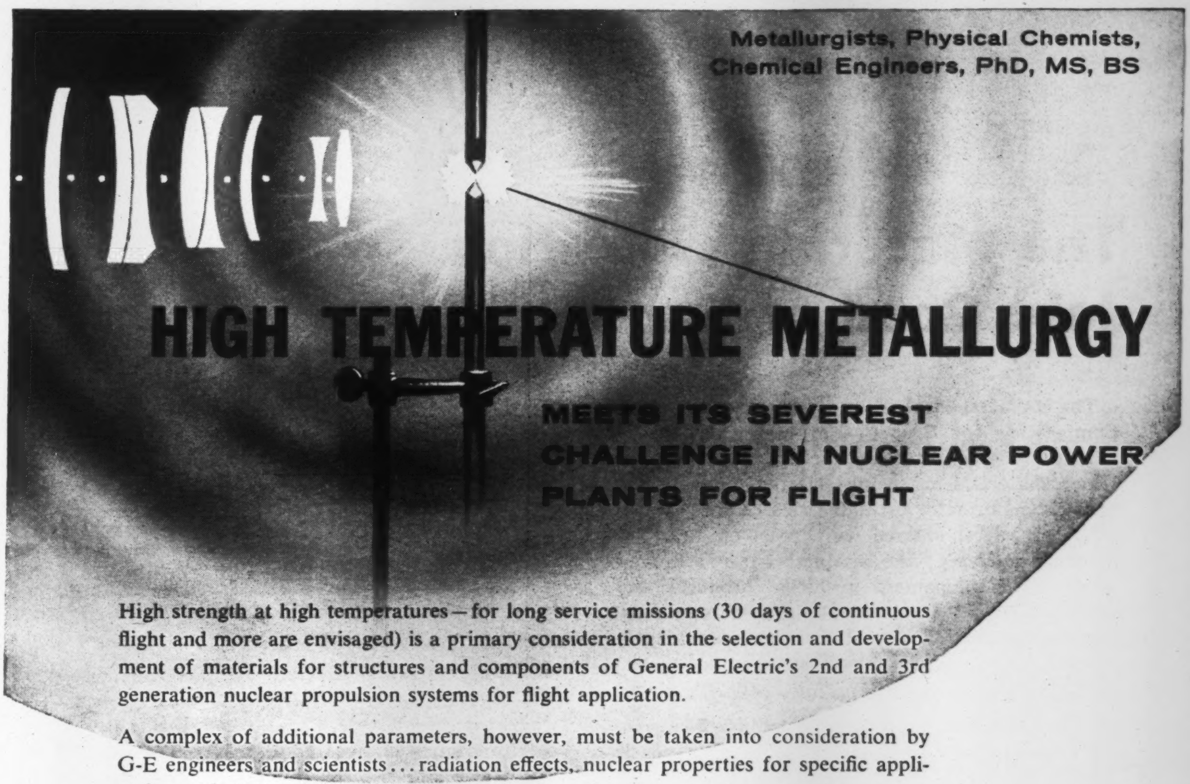

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CARRY OUT liaison with materials subcontractors. BS with 7-9 years experience in development or sales engineering.

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THE
LAST
WORD

The Materials Selection Job: Good or Bad?

by H. R. Clauser
Editor

The MATERIALS IN DESIGN ENGINEERING Awards Competition for Best Use of Materials (see p 121) provides an excellent picture of the way in which materials are being selected today in the product manufacturing industries. This year, as in other years, entries were received from all fields of industry; the products entered ranged from small components to large products and assemblies; and hundreds of different engineering materials, forms and finishes were represented.

Winners reflect good side

What observations and conclusions, then, can we draw from a critical review of this year's competition? As in the previous competitions, most of the winning entries displayed sound and progressive use of materials. Also, the winners showed definite evidence of using a rigorous engineering approach that involved a thorough analysis of all service requirements and a systematic evaluation of the numerous materials that might be suitable. Perhaps the best examples of this approach are the spray etching machine (p 126) and the water meter (p 122) entries, both of which won Awards of Merit. The etching machine entry, in particular, demonstrates how systematic materials selection often proceeds by a series of steps, progressively eliminating unsuitable materials until only the one material which best meets all the service and cost requirements remains.

But despite the high caliber of the winning entries, no one of them was singled out by the judges as representing a revolutionary or trend-setting use of engineering materials. Therefore, the judges withheld the First Award this year, and in its place created an additional five Awards of Merit.

Non-winners point up weaknesses

Turning to an appraisal of the non-winners, both the Board of Judges and ourselves were struck by the sharp drop in quality in many of the non-winning entries. A large number of the entries showed a serious lack of thoroughness in their approach to materials selection. In many cases there was little evidence that the broad range of materials possibilities was considered and that all service requirements were properly evaluated.

Also, a surprising number of entries gave little or no evidence that the materials under consideration were evaluated under the actual conditions the product would have to meet in service. Although it is true that standard or handbook property data must be heavily relied upon for design calculations, there is no substitute for service or simulated service testing to evaluate the performance of materials.

There were also a number of entries in which a new material was used without any attempt to redesign to take full advantage of the new material's characteristics. And finally, many of the entries showed a reluctance to even consider any material or form that could not fit into existing production facilities. Though it is true that existing equipment is an important factor when choosing materials, this fact should not summarily dismiss consideration of materials that require new processing methods or techniques. As some of the winning entries show, materials changes that also require process changes often lead to considerable cost savings.

A good job pays off

A review of the winning entries in this issue amply demonstrates that a thorough and imaginative approach to materials selection usually pays off in substantial cost reductions, improved quality or better design. Such dividends as these certainly should provide an incentive for more engineers and designers to give more thought to selecting the materials that will be used in their products.

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